

WITTECK DEVELOPMENT INC.

Open File Report 88-17

MINERALOGICAL INVESTIGATION OF
SEVERAL GOLD-BEARING ORES
(Project 5272)

by

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(Project 5272)

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WITTECK



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**MINERALOGICAL INVESTIGATION OF
SEVERAL GOLD-BEARING ORES**

Project No. 5272

for

**New Brunswick Department of Natural
Resources and Energy
Mineral Resources Division
P.O. Box 6000
Fredericton, New Brunswick
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April 16, 1987

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1.0 INTRODUCTION

At the request of Mr. George Sproul of NBNRE - Mineral Resources Division, six samples of various gold-bearing ores were submitted to Witteck Development Inc. for mineralogical investigation.

The samples represented ore material from Durham Resources (87-201, 87-203), Lacana's Alcida property (87-202) and Gordex Minerals' Cape Spencer property (87-251 through 87-253).

Of particular importance in this study were the gold occurrences, mineral associations and semi-quantitative mineralogy of the sulfide-oxide assemblages.

2.0 PROCEDURES

Five of the six samples represented broken material from surface trenches and diamond drill core sampling programs. These included sample numbers 87-202, 87-203, 87-251, 87-252 and 87-253.

Sample number 87-201 was a gravity concentrate from the tailings circuit of Durham Resources' Lake George antimony project.

Each of the five samples of broken ore were screened, as received, through a 50 mesh (295 micron) screen. Oversize material was reduced by shatterbox, using short stage grinds to minimize the percentage of very fine material, and passed over the 50 mesh screen. The oversize was reground until 100% of the sample passed 50 mesh.

The sample weights were recorded and are given in Table 1.

Table 1

SAMPLE WEIGHTS

<u>Sample No.</u>	<u>Sample Weight (grams)</u>	<u>Head Sample for Mineralogy (grams)</u>	<u>Retained</u>
87-201	17.93	5.11	12.82
87-202	72.00	20.00	52.00
87-203	119.20	20.00	99.20
87-251	78.44	20.00	58.44
87-252	142.76	20.00	122.76
87-253	135.91	20.00	115.91

Twenty gram head samples of the minus 50 mesh material were split from each of the five broken ore samples and a split of approximately five grams was retained from the Durham gravity concentrate.

The remainder of each sample was then vanned, using a gravity concentration plaque of 30 cm diameter, to concentrate the high density mineral fraction. After vanning, the tailings products were re-vanned to collect any remaining heavy minerals in the fines fractions. The products were then collected, filtered, dried and submitted for gold fire assay to assess the recovery of gold to the vanned concentrate. Due to the small amount of sample available, only the tailings products were assayed for gold. The results of the vanning procedures and assays are given in Table 2. Tailings assays were performed using one assay ton (30 gram) samples. Head assays were not made available for mass balance calculations.

Table 2

GOLD DISTRIBUTION IN VANNED PRODUCTS

<u>Sample No.</u>	<u>Sample Weight (g)</u>	<u>Conc. Weight (g)</u>	<u>Wt. %</u>	<u>Au in tailings g/t</u>
87-201	12.82	6.3	49.1	-
87-202	52.00	3.45	6.6	2.20
87-203	99.20	4.73	4.8*	8.51*
87-251	58.44	1.26	2.2	0.23
87-252	122.76	1.21	1.0	0.27
87-253	115.91	4.36	3.7	0.67

* Further vanning indicated that extremely fine grained sulphide mineralization occurred in the tailings product. Several stages of vanning were required to collect this fraction to the concentrate prior to submission for preparation of polished mounts.

The six vanned concentrate products were submitted, along with the six head samples, for preparation of 25 mm diameter polished mounts. Where sufficient vanned concentrate material was available, two polished mounts per sample were prepared. The polished mounts and associated sample materials are listed in Table 3.

Table 3

POLISHED SECTIONS

<u>Mount No.</u>	<u>Sample No.</u>	<u>Ore Head</u>	<u>Vanned Conc.</u>
1	87-201		X
2	87-201		X
3	87-201	X	
4	87-202		X
5	87-202		X
6	87-202	X	
7	87-203		X
8	87-203		X
9	87-203	X	
10	87-251		X
11	87-251	X	
12	87-252		X
13	87-252	X	
14	87-253		X
15	87-253		X
16	87-253	X	

Each polished mount was examined under reflected light using a Leitz polarizing microscope with magnifications of 50X, 100X, 200X, 500X and 1250X, the latter with oil immersion. Each sample was scanned along parallel traverses at 300 to 500 micron intervals.

Areas of interest were photographed using a 35 mm camera attachment with ET160 transparency film. In addition, important or unknown particles were marked for subsequent scanning electron microscopy using a diamond tipped marker objective. The circular location markers were linked by using an aluminum compound marker pen. The aluminum provided a trail between individual SEM sites to increase the productivity of the SEM time share. Particles of interest were analyzed by energy dispersive x-ray techniques. Spectra, with peak identifications, were photographed from the CRT display, using a Polaroid camera.

3.0 RESULTS

After examination of the polished mounts, the following results were obtained.

3.1 Sample #87-201

Sample Type - Durham gravity concentrate from tailings circuit

<u>Mineral Assemblage</u>	<u>Distribution</u>
Pyrite	72%
Arsenopyrite	15%
Pyrrhotite	4%
Marcasite	3%
Stibnite	2.5%
Native Antimony	1%
Magnetite-ilmenite	1%
Hematite-goethite	1%
Chalcopyrite	0.5%
Tetrahedrite	0.5%
Sphalerite	0.5%
Berthierite	0.5%
Sternbergite	0.5%

Native gold - not observed

Overall, the average particle size averages approximately 65 to 70 microns with an estimated 5% of the particles greater than 100 microns. The plus 100 micron fraction comprises approximately 20-25% of the volume distribution with individual field counts ranging from 10 to 40%. Overall liberation of

the sulfides is estimated at 75 to 80% with particles of less than 50 microns exhibiting 60-65% liberation. Non-liberation occurs in grains ranging from less than two microns to greater than 100 microns. Gangue content, however, ranged from less than 20% to greater than 98%, particularly in the latter, with minute disseminated crystals of arsenopyrite, pyrite and stibnite. The latter typically exhibited poor liberation in the minus-fifty micron grouping.

The product was comprised primarily of pyrite and arsenopyrite. Idiomorphic to xenomorphic, typically subidiomorphic, pyrite crystals (Photograph 6) formed massive to strongly sieved overgrowths of pyrite intergrown with silicate gangue. Hollow skeletal crystals were also observed. Intergrowths with arsenopyrite and/or silicates, overgrowths upon arsenopyrite and atoll structures (Photograph 7) of pyrite over fine grained pyrite and pyrrhotite were present. Layered or banded crystal aggregates of fine grained pyrite, arsenopyrite and marcasite, with crystals ranging from 1-5 microns, were observed. Broken and fractured pyrite crystals and aggregates exhibited mild to strong degrees of brecciation. Intercrystal porosity may contain minute particles of antimony minerals, stibnite, berthierite, native antimony, tetrahedrite and chalcopyrite. Encapsulated grains of pyrrhotite, ranging from 5-20 microns in diameter, were also present. The pyrite displayed incipient replacement by marcasite and goethite.

The arsenopyrite formed idiomorphic (Photograph 6) to xenomorphic crystals, commonly as crystal aggregates. Crystals range from less than 2 microns to a maximum of 200 microns and average 15 to 30 microns. Angular xenomorphic fragments average 50 to 65 microns and range to approximately

210 microns. The arsenopyrite may occur as very fine (less than four micron) crystals in highly sieved aggregates with pyrite and marcasite. Arsenopyrite euhedra may be enclosed within pyrrhotite and stibnite. Inclusions of rutile, ranging from 5 to 25 microns, commonly occur within arsenopyrite.

Pyrrhotite typically occurs as xenomorphic angular particles (Photograph 6) ranging from less than 1 micron to a maximum of 150 microns with an average size of approximately 40 microns. The massive pyrrhotite formed middling particles with arsenopyrite, overgrowths upon pyrite and arsenopyrite, and locally exhibited partial replacement along crystal planes by arsenopyrite and iron oxyhydroxides. Blebs of native antimony were commonly encapsulated in the pyrrhotite. The pyrrhotite: native antimony ratio varied from free particles of both types. Pyrrhotite also occurred along narrow fractures within silicates and sulphides to less than 0.4 microns in width.

Marcasite occurs as aggregates of minute laths of less than 20 microns and crystals, less than five microns in diameter, in aggregates up to 125 microns. Marcasite also occurred as interstitial cements to pyrite-arsenopyrite.

Stibnite (Photograph 4) occurred as liberated, angular xenomorphic to idiomorphic crystals and aggregates with coarse prisms to 50 microns and anhedral to 170 microns. Aggregate particles of both stibnite and berthierite (Photograph 5) up to 45 x 110 microns form intergrowths with silicates. Stibnite also formed middling associations with arsenopyrite, formed along crystal margins of pyrite and as interstitial cements in brecciated pyrite and arsenopyrite, the latter case as 1 to 40 micron wide lenticles and minute xenomorphic grains.

Native antimony formed coarse free particles up to 90 microns in diameter with typical grains of less than 50 microns. Intergrowths with pyrrhotite (Photograph 1) and stibnite typically exhibit xenomorphic to subidiomorphic antimony of less than 25 microns diameter. Antimony formed interstitial to arsenopyrite euhedra and locally enclosed particles of stibnite and pyrrhotite (Photograph 2).

Accessory minerals comprised Fe-Ti oxides, chalcopyrite, tetrahedrite and sphalerite. Magnetite-ilmenite formed coarse angular grains up to 100 microns with ragged to lamellar intergrowths and incipient replacement by hematite-goethite. The secondary oxides occurred as ragged, locally banded compact grains and open framework aggregates. Hematite also formed massive subidiomorphic blades up to 30 microns. Chalcopyrite formed fine inclusions in arsenopyrite of less than twelve microns, free angular particles to 25 microns, and middling particles up to 25 microns with arsenopyrite. Tetrahedrite occurred as fine interstitial cements, of less than two microns width, with pyrite (Photograph 3) and arsenopyrite and also as middling particles, up to 30 by 80 microns, with arsenopyrite. Sphalerite formed rare free particles up to 45 microns diameter with abundant 1 to 4 micron exsolved particles of chalcopyrite. Sternbergite formed primarily as narrow 1 to 3 micron lenticles along grain boundaries of arsenopyrite and pyrite, massive fibrous liberated particles up to 50 microns and middling particles with arsenopyrite and pyrite.

3.2 Sample #87-202

Sample Type - Lacana Alcida property

<u>Mineral Assemblage</u>	<u>Distribution</u>
Arsenopyrite	52%
Pyrrhotite	24%
Pyrite	20%
Other Minerals	4%
- Rutile, Sphene, Leucoxene	- 75%
- Chalcopyrite	- 15%
- Marcasite	- 4%
- Fe oxyhydroxides	- 4%
- Hematite	- 2%

Native Gold - 8 occurrences/32 grains

Overall, the coarse arsenopyrite, pyrite and pyrrhotite displayed high degrees of liberation, though typically incomplete with 0 to 20% silicates. The plus 100 micron fraction exhibited greater than 85% liberation (particles containing up to 20% gangue extended liberation to 90% of sulphides). The 20 to 100 micron fraction exhibited greater than 50% liberation while the minus 20 micron grouping displayed less than 30% liberation from gangue. The fine grained pyrite and arsenopyrite formed idiomorphic to subidiomorphic crystals, up to 50 microns, enclosed or middling with silicate gangue. Pyrrhotite typically occurred as very fine to coarse xenomorphic grains primarily enclosed by gangue. The coarse fraction occurred as middling exposed associations, locally as interstitial grains to gangue. Stibnite was rarely observed but occurred as liberated grains

up to 140 microns in length. Sphene, rutile and leucoxene occurred as abundant free particles, commonly exceeding 300 microns in diameter. Intergrowths of secondary oxysilicates and silicate gangue were also common, particularly in the minus 100 micron fraction.

In the vanned concentrate, sulphides generally displayed excellent degrees of liberation with pyrite and arsenopyrite at greater than 98%. Pyrrhotite commonly occurred in middling and encapsulated grains within silicates (approximately 80% liberation observed). Silicate gangue content within particles ranged from 0 to 70% and the associated pyrrhotite typically ranged from less than 5 to 80 microns.

Thirty-two grains of native gold were observed within eight occurrences. The native gold occurred as smooth to highly ragged grains ranging in size from 0.3 microns to a maximum of 4-6 x 22 microns. Several textural associations were observed though the gold exhibited a strong spatial relationship to arsenopyrite. Gold occurred as fine encapsulated particles (Photograph 13) with individual arsenopyrite crystals (possibly on healed fractures) which typically exhibited high degrees of micropores, and grain boundary and fracture controlled mineralization (Photographs 8, 9 and 12) within and adjacent to arsenopyrite crystals. The gold was locally associated with pyrrhotite cement (Photographs 9 and 10) which accompanied the gold mineralization within intercrystal porosity, fracture porosity and adjacent to arsenopyrite with coarse grained pyrrhotite (Photograph 11). The occurrences, particle sizes, and mineral associations are listed in Table 4.

Table 4

GOLD OCCURRENCES

<u>Occurrence No.</u>	<u>Particle Size</u>	<u>Association</u>
1	1.5 x 3.5	Healed microfracture in arsenopyrite
2	0.7 x 1.6	Within arsenopyrite aggregate
3	1.4 x 1.8	Within arsenopyrite aggregate
4.	0.3 x 0.4	Within arsenopyrite aggregate
5	2x4, 2-3.5x12	Fractures in arsenopyrite
6	4-6 x 22	Middling arsenopyrite
7	4.5 x 6	Middling arsenopyrite, pyrrhotite
8	24 grains 3 x 3.5	Fracture (grain boundary in
	1 x 6	arsenopyrite
	1 x 4.5	" "
	4 x 16	" "
	0.7 x 6	" "
	remainder 1.5	

The mineral assemblage of the heavy mineral concentrate was primarily composed of arsenopyrite with lesser amounts of pyrrhotite and pyrite. The arsenopyrite typically occurred as idiomorphic to xenomorphic crystals, were commonly fragmented with minor void porosity, and ranged in size from less than two microns to 150 x 600 micron prismatic crystals. Average size of the arsenopyrite was estimated at 150 microns. Dendritic to skeletal textures with massive prismatic to hollow skeletal crystals are present. Crystal aggregates with extensive intercrystal porosity commonly contain interstitial pyrrhotite in 1-10 micron crystals. Also, fine grained arsenopyrite, typically less than 20 microns, occurred as islands within coarse pyrrhotite (Photograph 14). The arsenopyrite exhibited complex to simple intergrowth twins. Minor lobes of iron oxyhydroxides, rutile and leucoxene replace the arsenopyrite preferentially along cleavage surfaces and grain boundaries.

Pyrrhotite occurred as xenomorphic grains up to 450 microns in diameter with an average size of approximately 120 microns. Internal porosity varies from nil to high with abundant rutile needles. Fracturing ranged from low to moderate and oxidation to hematite and iron oxyhydroxides was weakly to strongly developed at grain boundaries and along cleavage surfaces. Pyrrhotite occurred as a cementation phase for both pyrite (Photograph 15) and arsenopyrite (Photograph 14) and commonly formed large grains with enclosed idiomorphic to xenomorphic pyrite and/or arsenopyrite. Middling grains were also observed with pyrrhotite overgrowths upon pyrite or arsenopyrite.

Pyrite formed idiomorphic to xenomorphic, simple and aggregate grains ranging from less than 5 microns to a maximum of 400 microns. Average size of the pyrite was less than 100 microns. Massive to zoned, sieved crystals were observed and weak to very strong fracturing and brecciation were present. Middling associations with pyrrhotite (Photograph 15), encapsulated fine grained particles of pyrrhotite and later fracture filling pyrrhotite comprised additional mineral textures. Rarely, pyrite formed as interstitial cements to arsenopyrite crystal aggregates.

Rutile, sphene and leucoxene occurred as very fine crystals less than 5 microns to coarse granular aggregates up to 400 microns in diameter. The secondary oxides occurred as pseudomorphic replacements after magnetite-ilmenite and commonly occurred in middling intergrowths with arsenopyrite, pyrite, pyrrhotite and chalcopyrite. Minute 1 to 5 micron grains of rutile and sphene may occur along cleavage surfaces of silicate gangue and, less commonly, along fracture and cleavage surfaces of sulfides.

Chalcopyrite occurred primarily as middling intergrowths with pyrrhotite (Photograph 16) and exhibit smooth, simple contact to myrmekitic textures. The chalcopyrite also formed as interstitial cement to arsenopyrite with an overcoat of pyrrhotite. The chalcopyrite ranges from 10 to 80 x 160 microns with an average size of 40 microns.

Marcasite, iron oxyhydroxides, and hematite occurred primarily as minor replacements of primary sulfides. Marcasite and iron oxyhydroxides replaced pyrrhotite with minute xenomorphic grains, commonly in fractures or as lobate grain boundary alteration zones. Hematite locally formed coarse idiomorphic crystals (Photograph 17) after pyrrhotite. The hematite displayed excellent triple junction boundaries, strong cleavage and contained minute relicts of pyrrhotite and disseminated idiomorphic to xenomorphic arsenopyrite.

3.3 Sample #87-203

Sample Type - Durham auriferous ore

<u>Mineral Assemblage</u>	<u>Distribution</u>
Arsenopyrite	70%
Pyrite	25%
Other Minerals	5%
- Rutile, Sphene	- 45%
- Pyrrhotite	- 20%
- Sternbergite	- 12%
- Tetrahedrite	- 8%
- Stibnite	- 5%
- Native Antimony	- 3%
- Chalcopyrite	- 3%
- Berthierite	- 3%
- Allemontite	- 1%
- Molybdenite	- 0.5%

Native Gold - 2 occurrences/2 grains

Overall, liberation from silicate gangue within the vanned concentrate product was approximately 98-99% in the +50 micron fraction. However, liberation of the fine grained sulfides, particularly in the minus 25 micron fraction was approximately 50-60%. Examination of the feed sample indicated that high percentages of very fine grained arsenopyrite exhibited poor degrees of liberation from silicate gangue.

Two grains of native gold were observed from two occurrences. The native gold formed ragged equant particles associated with fractures within arsenopyrite (Photographs 18 and 19). The occurrences, particle size and associations are given in Table 5.

Table 5

GOLD OCCURRENCES

<u>Occurrence#</u>	<u>Particle Size</u>	<u>Association</u>
1	0.8 x 1.5	Microfracture in arsenopyrite
2	4 x 4	Microfracture in arsenopyrite

The high gold assay in the initial vanned tailings product and the paucity of gold within the vanned concentrate products suggests that the gold may occur in submicroscopic particles, perhaps within the fine grained arsenopyrite and/or gangue silicates.

The mineral assemblage of the vanned concentrate product was primarily comprised of arsenopyrite with lesser pyrite. The arsenopyrite and pyrite exhibited a crude bimodal distribution with a low percentage of very coarse idiomorphic to xenomorphic crystals and crystal aggregates. Pyrite and arsenopyrite

exhibited widely fluctuating frequency distribution with size. Of the coarse +200 micron crystals, pyrite and arsenopyrite was approximately 80:20 while in the minus 200 micron group pyrite:arsenopyrite was approximately 20:80. At less than 75 microns, pyrite:arsenopyrite was less than 10:90. The frequency of coarse +100 micron crystals was 10% with 20% of this fraction greater than 200 microns. Volume distributions suggest that the +100 micron fraction comprises 30% with the +200 micron grains at less than 10%. Approximately 75% of the +150 micron fraction comprised massive, myrmekite-type intergrowths of pyrite and arsenopyrite. Locally, pyrite was observed as a cement around arsenopyrite crystals. The arsenopyrite, which ranged in size from less than 1 micron to greater than 200 microns, formed idiomorphic to xenomorphic crystals and crystal aggregates. Fine grained arsenopyrite, of less than 20 microns, commonly occurred as middling particles with silicate gangue (approximately 70% of particles). Liberation of the arsenopyrite in the feed and vanned concentrate was steadily lowered with decreasing size (+50 micron -95%, -50 microns -70%, -20 microns -30%). Crystal aggregates, up to 550 microns in diameter, contain interstitial cement, comprised of pyrrhotite, pyrite, sternbergite, stibnite, berthierite, tetrahedrite and native antimony. Middling associations with pyrrhotite (Photograph 36) and sternbergite (Photographs 34, 35 and 36) were very common. The overgrowths occurred primarily along single crystal margins though locally coated the entire grain. Rim encrustation ranged from 5 to 100% coverage. The volume per cent of pyrrhotite or sternbergite for individual occurrences ranged from less than 2% to 50% with an average of less than 3 to 5%. Rarely, coarse particles of pyrrhotite-sternbergite occupied up to 90% of the fragment. Locally, the arsenopyrite crystals exhibited incipient to pervasive cleavage-controlled replacement by rutile and sphene (Photograph 37).

Pyrite exhibited similar liberation and mineral inclusion textures to the arsenopyrite. The pyrite formed idiomorphic to xenomorphic crystals ranging up to 250 microns in diameter with an average size of 70 microns. Intergrowths between pyrite and arsenopyrite were very common and pyrite exhibited variable anisotropism consistent with arsenic substitution. Locally, coarse idiomorphic pyrite displayed overgrowths comprising skeletal pyrite with silicate gangue (Photograph 38). As mentioned for arsenopyrite, the pyrite contained numerous minerals as inclusions and within intercrystal porosity of aggregates of 1-5 micron diameter pyrite crystals. These included pyrrhotite, stibnite, berthierite, tetrahedrite, sternbergite, chalcopyrite and native antimony.

Pyrrhotite occurred as subidiomorphic to xenomorphic crystals ranging in sizes up to 100 x 210 microns, with an average size for liberated grains of 90 microns. Approximately 70% of the pyrrhotite was liberated with the remaining 30% primarily occurring as middlings with arsenopyrite, and less commonly, pyrite. The middling particles comprise two textural types. Type one included minute xenomorphic inclusions and intercrystal pore-filling pyrrhotite, typically less than 10 microns in diameter, within pyrite. Type two was comprised principally of elongate to oblong middling particles of pyrrhotite attached to arsenopyrite. The middling grains comprised from 2 to 70% of the particle. In addition, pyrrhotite contained inclusions of native antimony (Photograph 22). The inclusions, and also middling grains of antimony, ranged from 0.5 to 15 microns in diameter.

Sternbergite occurred primarily as elongate, idiomorphic to xenomorphic grains attached to arsenopyrite crystals (Photographs 34, 35 and 36) and, less commonly, as liberated ragged, angular fragments. The sternbergite displays its very soft nature with extensive pitting and also exhibits numerous examples of platy flakes with twisted fibrous textures similar to molybdenite. Approximately 50% of the sternbergite formed these middling associations with the remainder as liberated particles. The sternbergite may comprise from less than 2% to a maximum of 55% of individual particles. Typically, the sternbergite averaged 2-15 microns in width with lengths less than 75 microns and maximum middling type particles up to 30 x 140 microns. Liberated particles up to 50 microns in diameter were observed.

Tetrahedrite (Photograph 28) primarily occurred as middling and encapsulated grains associated with pyrite and arsenopyrite but also occurred with stibnite, chalcopyrite, pyrrhotite, and native antimony (Photographs 27, 29 and 30). The sulphosalts ranged in size from less than 5 microns to approximately 90 microns. Interstitial cementation by tetrahedrite (Photographs 30 and 31), in grains up to 75 microns, enclosed pyrite, chalcopyrite, and native antimony.

Stibnite formed liberated, angular, xenomorphic particles, commonly exhibiting extensive development of parallel lamellae (Photograph 20) and intersecting deformation twins, and ranging in size from 30 to 150 microns. In addition, stibnite also occurred as minute inclusions, commonly from less than 5 to 10 microns, and as interstitial cement within pyrite, arsenopyrite, and pyrrhotite crystal aggregates. Approximately 85% of the stibnite occurred as free grains while the other 15% formed middling and encapsulated associations.

Two examples of coarse middling intergrowth particles of stibnite, allemontite and native antimony, were observed (Photograph 24). The aggregate grains had a maximum diameter of 190 x 270 microns and was primarily comprised of stibnite (45%-50%), with lesser allemontite (35-40%) and minor native antimony. The individual minerals occur primarily as minute xenomorphic to subidiomorphic, equant crystals with weak to extensive fracture development, particularly in the stibnite. The native antimony appeared to fill fractures and interstitial crystal porosity between the intergrown allemontite (Photograph 25) and stibnite.

Native antimony (Photograph 23) also occurred as numerous middling and encapsulated particles, particularly within pyrrhotite (Photograph 22) and upon intercrystal porosity of arsenopyrite. Free liberated particles contributed only 5% of the native antimony. The antimony typically occurred in grain sizes from 0.5 to 25 microns and ranged in abundance from less than 2% to approximately 60% of the middling particles.

Berthierite, the iron sulfosalt, typically occurred as aggregate grains (Photograph 21) comprising crystals of less than 15 microns diameter and commonly with interstitial silicate minerals. Minute angular, twinned particles of berthierite also formed encapsulated associations within arsenopyrite and pyrite. Grains up to 18 microns were observed. Coarse berthierite prisms, associated with silicate gangue, had a maximum size of 90 by 150 microns. Overall, approximately 80% of the berthierite occurred as free grains, although by frequency, 90% of the berthierite formed the minute middling type grains.

Chalcopyrite formed liberated, angular particles (Photograph 26) up to 40 microns in diameter, middling associations with arsenopyrite with grains to 25 microns, and encapsulated crystals interstitial to tetrahedrite (Photograph 27), arsenopyrite, and pyrite, of up to 35 microns in diameter. Molybdenite (Photograph 33) formed rare middling particles with stibnite with flakes up to 6 x 20 microns and aggregate size up to 40 x 50 microns. The molybdenite displayed ragged bent and twisted flakes intergrown with xenomorphic stibnite (Photograph 32).

3.4 Sample #87-251

Sample Type - Gordex Cape Spencer drill core.

<u>Mineral Assemblage</u>	<u>Distribution</u>
Pyrite	85%
Rutile, Sphene	11%
Other Minerals	4%
- Galena	- 30%
- Chalcopyrite	- 24.4%
- Stibnite	- 16.5%
- Arsenopyrite	- 12.2%
- Pyrrhotite	- 11.5%
- Tetrahedrite-Tennantite	- 2%
- Magnetite, FeOOH	- 1%

Native Gold - 3 occurrences/4 grains

Overall liberation of sulphide minerals was widely variable between mineral types particularly due to the average size distributions. At the grind of minus 50 mesh (295 microns), approximately 95% of pyrite was completely liberated. Arsenopyrite exhibited 60% liberation with the remainder as middling and encapsulated crystals. Middling particles of chalcopyrite-galena display 75 to 80% liberation from silicates. The remainder of these particles exhibit locked to locally middling exposed relationships. Approximately 35-40% of the chalcopyrite formed middling particles with galena with 55 to 60% fully liberated and approximately 5% middling with pyrite. Pyrrhotite exhibits 90% liberation with 10% middling with gangue. Stibnite displayed 50% liberation with 5% locked and 15% middling exposed particles with silicates.

Native gold occurrences (3 occurrences/4 grains) were characterized by strongly lenticular gold particles associated with fractures or grain boundaries of pyrite (Photograph 39). The gold particles ranged in width from less than 1 micron to 16 microns and in length up to 50 microns. The occurrences are given in Table 6.

Table 6

GOLD OCCURRENCES

<u>Occurrence #</u>	<u>Particle Size</u>	<u>Association</u>
1	0.7 x 10	Fracture in pyrite
2	0.5-1 x 24	Middling at edge of pyrite
3	4-16 x 50	Middling at edge of pyrite

The gold particles exhibit smooth to ragged grain boundaries and lensoid forms along the long axis of the particles. Photograph 40 displays the composition of the silver-bearing gold mineralization.

The vanned concentrate product is primarily comprised of pyrite in fractured, angular, rarely idiomorphic crystals ranging in size from less than 10 microns to 175 by 500 microns. The majority of grains range from 50 to 200 microns and average approximately 100 microns. The pyrite exhibited minor to moderate degrees of sieving with very fine inclusions of rutile and sphene ranging from less than 2 to 50 microns. The oxide inclusions may exceed 50% of the volume in highly porous pyrite. The pyrite also contained numerous inclusions of galena ranging from 1 to 20 microns in diameter. Elongate grains of galena, up to 10 x 90 microns, occurred along cleavage surfaces of pyrite.

Rutile and sphene, possibly also leucoxene, typically formed crystals of less than 5 microns and aggregates up to 200 microns. Coarse crystals up to 70 microns exhibited parallel lamellae and interpenetrant wedge twins. Subidiomorphic sphene commonly occurred as a peripheral alteration phase adjacent to the rutile.

Galena (Photograph 42) formed liberated subidiomorphic to xenomorphic particles up to 50 x 100 microns and averaging approximately 15-50 microns. Middling intergrowths with both pyrite and chalcopryite were common. In particular, galena formed up to 15% of particle volumes with pyrite as middling exposed and interstitial stringer type particles up to 10 by 100 microns. Middling grains of galena with chalcopryite ranged from 5 to 95% galena.

Chalcopyrite occurred as middling particles and intergrowths with zircon, silicate gangue, galena (Photograph 43) and pyrite. Free particles up to 90 x 120 microns were observed while inclusions in pyrite and gangue silicates ranged from less than 0.2 microns to 35 microns. Stibnite formed numerous equant subidiomorphic to xenomorphic aggregate grains (Photograph 41) and locally prismatic crystals ranging from less than 20 microns to 100 x 150 microns and averaging approximately 75-80 microns. Intergrowths with silicate gangue contained up to 35% stibnite as less than 20 micron crystals. Arsenopyrite formed liberated idiomorphic to subidiomorphic crystals up to 40 by 130 microns and averaging approximately 35-40 microns. Middling intergrowths with gangue commonly comprised aggregates of arsenopyrite crystals ranging from 2 to 20 microns. Pyrrhotite typically formed ragged liberated grains up to 60 x 200 microns and lesser middling particles with silicate gangue. Tetrahedrite-tennantite occurred as 15 to 30 micron particles locally coated by galena (20% galena:80% tennantite) and coarse middling particles with galena and minor chalcopyrite (Photograph 43). The tennantite particle (Photograph 44) ranges from 10 to 50 x 110 microns and exhibits irregular consertal boundary textures. Magnetite formed rare liberated particles up to 70 x 100 microns and locally contained minute inclusions, less than 25 microns in diameter, of galena and chalcopyrite. Iron oxyhydroxides formed rare oxidation replacement of pyrite along fracture surfaces.

3.5

Sample #87-252

Sample type - Gordex Cape Spencer oxide

Mineral AssemblageDistribution

Pyrite	60%
Type I (no oxidation)	- 40%
Type II (50% oxidation)	- 30%
Type III (50% oxidation)	- 30%
Fe oxyhydroxides	18%
Type I (pervasive oxidation)	- 65%
Type II (up to 10% sulphide relicts)	- 35%
Hematite, Rutile	18%
Magnetite-Ilmenite	3.5%
Type I (massive magnetite)	- 75%
Type II (exsolution of ilmenite)	- 25%
Other Minerals	0.5%
- Pyrrhotite	- 40%
- Chalcopyrite	- 24%
- Stibnite	- 23%
- Arsenopyrite	- 8%
- Native Antimony	- 2%
- Galena	- 2%
- Tetrahedrite-Tennantite	- 1%

Native Gold - 16 occurrences/86 grains

Overall, the sulfides and oxides exhibit approximately 90% liberation from the silicate gangue after grinding through 50 mesh. Within the vanned concentrate, non-liberation from silicates is limited to intergrowths of bladed prismatic hematite and ilmenite with interstitial gangue silicates.

Eighty-six particles of native gold (Photograph 47) were observed in sixteen occurrences. The gold mineralization is typically very fine grained averaging approximately 0.8 to 1.0 microns. Maximum particle size was 3.5 by 6.0 microns with the maximum length of 30 microns with 0.5 to 1 micron width. The occurrences form several textural associations including minute free particles, encapsulated particles within pyrite (Photograph 45), fracture controlled within and middling to pyrite, encapsulated and middling to secondary Fe oxyhydroxides (Photographs 46 and 38). The gold particle sizes and mineral associations are listed in Table 7.

Table 7

GOLD OCCURRENCES

<u>Occurrence #</u>	<u>Particle Size</u>	<u>Association</u>
1	3.5 x 6	Free
2	0.2 x 0.3	Locked in pyrite
3	0.6	Locked in pyrite
4	0.7, 1.2 x 1.6	Locked in pyrite
5	0.8-1.2 (4 grains)	Locked in pyrite
6	0.7	Fracture in pyrite
7	3 x 3	Fracture in pyrite
8	0.3	Middling FeOOH
9	0.5-1 x 30	Middling FeOOH
10	1 x 6, 1 x 3	Middling FeOOH
11	1.6 x 1.8	Middling FeOOH
12	1 x 4.5	Locked FeOOH
13	0.15-1.5 (58 grains)	Locked FeOOH
	3 (10 grains)	Locked FeOOH
14	0.3	Fracture FeOOH
15	0.4 x 2	Fracture FeOOH
16	1.2 x 15, 0.6 x 6.5	Fracture FeOOH

The mineral assemblage was dominated by pyrite, hematite and iron oxyhydroxides, the latter due to surficial oxidation of the hypogene sulfide mineralization. Pyrite formed idiomorphic to xenomorphic crystals ranging from less than 10 to a maximum dimension of 400 microns. The majority ranged from 150 to 350 microns and averaged approximately 200 microns. The degree of fracturing was highly variable from massive crystals to strong brecciation. Sieve textures were weakly to moderately developed with inclusions of rutile and

sphene being common. As noted in the mineral assemblage listing, approximately 40% of the pyrite exhibited a lack of oxidative replacement with 30% of the pyrite displaying less than 50% replacement, primarily fracture and grain boundary controlled and the remaining 30% exhibiting 50-90% oxide replacement. The oxyhydroxides form compact to open framework coating along fractures and as progressive lobate replacement fronts (Photograph 49). Pseudomorphic replacement of pyrite was common (Photograph 50). Shrinkage cracks and brecciation, along with silica addition, characterized the outer alteration zones. The oxyhydroxides also occurred as extremely fine felted masses of goethite-lepidocrocite within the open framework oxyhydroxides. Pervasive oxidation occurred in 65% of the particles with the remaining 35% exhibiting up to 10% pyrite relicts.

Hematite occurred as abundant idiomorphic to subidiomorphic blades and laths in radial arrays up to 550 microns in length (Photograph 52). The fibrous arrays are commonly undulating, with contorted and folded lenticles. Laths, of less than 20 microns in length, commonly exhibiting simple, lamellar, and interesting lamellar twins, are intergrown with silicates. Coarse blades of hematite display exsolved blebs of magnetite, less than 10 microns, and excellent twin structures. Incipient to pervasive replacement by iron oxyhydroxides was observed.

Magnetite occurred as coarse free subidiomorphic to xenomorphic particles ranging from 40 to 450 microns and averaging 85 microns in diameter (Photograph 51). Lamellar exsolution of hematite and ilmenite were common. Pseudomorphs by iron oxyhydroxides, of magnetite octahedra were observed.

Pyrrhotite typically occurred as angular xenomorphic free particles (Photograph 50) ranging up to 75 microns and averaging 50 microns. The pyrrhotite locally occurred as minute inclusions, less than 40 microns, locked within iron oxyhydroxides.

Chalcopyrite formed free, angular grains to 80 x 150 microns, and commonly as minute blebs within pyrite. The inclusions also occurred within hematite and ranged from subrounded to angular particles of less than 15 microns in diameter. Stibnite formed several coarse, liberated particles up to 100 x 200 microns. Arsenopyrite formed idiomorphic to xenomorphic crystals up to 70 microns, aggregates to 90 x 120 microns, and locally exhibited incipient replacement by sphene, rutile and iron oxyhydroxides. Native antimony formed minute idiomorphic to xenomorphic crystals ranging from 1 to 10 microns in diameter. The antimony formed middling and encapsulated crystals (Photograph 50) with a pyrrhotite-silicate cementation overgrowth. The antimony may form linear blebs parallel to the pyrrhotite cleavage. Galena formed rare middling particles with pyrite and also occurred as fine angular to rounded inclusions, of less than 20 microns diameter, within pyrite. Tetrahedrite-tennantite formed minute particles within the intercrystal porosity of pyrite aggregates.

3.6

Sample #87-253

Sample Type - Gordex Cape Spencer oxide

<u>Mineral Assemblage</u>	<u>Distribution</u>
Pyrite	84%
Type I (no oxidation)	- 73.5%
Type II (50% oxidation)	- 17.5%
Type III (50% oxidation)	- 9 %
Fe oxyhydroxide	7%
Hematite, Rutile, Magnetite-Ilmenite	7%
Other Minerals	2%
- Chalcopyrite	- 75%
- Galena	- 20%
- Bornite	- 3%
- Covellite-Chalcocite	- 2%

Native Gold - 31 occurrences/36 grains

Overall, approximately 1% of the feed was comprised of primary oxides, sulphides and secondary iron oxyhydroxides. After grinding to pass 50 mesh screens (295 microns), liberation of plus 50 micron diameter oxides and sulphides was approximately 90% while 20-50 micron particles exhibit 75% liberation and minus twenty micron grains exhibited approximately 50% liberation (30% for oxides, 75% for sulphides). The non-liberated coarse particles comprised locked and middlings types with 40-75% sulphide or oxide mineral. The abundances

of less than 40% were restricted to aggregates of fine hematite laths in a matrix of silicates. The fine oxide and, less commonly, sulphides, may range from 1% to 35% of the particle volume.

Thirty-six grains of native gold were observed in thirty-one occurrences. The gold particles were primarily less than 3-5 microns in equivalent diameter although several coarse particles ranged from 25 to 88 microns in diameter (Photograph 53). The gold particles exhibited several associations including encapsulated particles within pyrite (Photograph 56) and/or FeOOH, fracture controlled particles within pyrite and/or FeOOH (Photograph 57), encapsulated particles within silica, middling associations with pyrite and polymineralic associations with chalcopyrite and/or galena within fractions or as inclusions within pyrite. The occurrences, particle size, and associations are given in Table 8. The chemical composition of a typical gold grain is given in Photograph 54.

Table 8

GOLD OCCURRENCES

<u>Occurrence #</u>	<u>Particle Size</u>	<u>Association</u>
1	5 x 8	Locked in pyrite
2	2.5 x 4, 0.5 x 3	Locked in pyrite
3	2 x 3.5, 1 x 3	Locked in pyrite
4	4 x 4	Locked in pyrite
5	3 x 4	Locked in pyrite
6	0.8 x 1.5	Locked in pyrite
7	3 x 4	Locked in pyrite
8	12 x 55	Locked in pyrite (Fracture control)
9	5 x 5	Locked in pyrite (Fracture control)
10	80 x 88	Locked in pyrite (Fracture control)
11	1 x 7	Locked in pyrite (Fracture control)
12	1 x 2	Locked in pyrite (Fracture control)
13	1 x 1.2	Locked in pyrite (Fracture control)
14	0.5 (5 grains)	Locked in pyrite (Fracture control)
15	19 x 26	Locked in pyrite (Fracture control)
16	1.5 x 4	Locked in pyrite (Fracture control)
17	2.5 x 4	Locked in pyrite (Fracture control)
18	1 x 7	Fracture in pyrite
19	0.2	Fracture in pyrite
20	12 x 7	Fracture in pyrite
21	1.5 x 8	Fracture in pyrite
22	25 x 27	Fracture in pyrite
23	0.7-4 x 14	Fracture in FeOOH
24	1.5 x 4	Locked in FeOOH
25	1 x 1	Locked in FeOOH
26	1.5 x 3.5	Locked in FeOOH
27	22 x 23	Locked in FeOOH
28	1.7 x 2	Middling with pyrite
29	0.8 x 3.5	Middling pyrite - FeOOH
30	1 x 4	Locked in silicate
31	0.7 x 2	Locked in silicate

As observed in Table 8, the majority of the gold mineralization exhibits a strong spatial relationship to pyrite and the secondary equivalents, FeOOH. Much of the mineralization is apparently controlled by microfractures within the pyrite (Photographs 53, 55 and 57). Numerous locked particles of gold may occur along healed microfractures (Photograph 56). The association of the microfractures is best observed in the partially oxidized pyrite (Photograph 57) where minute gold grains occur in FeOOH aggregates at sites of preferential oxidation (Photograph 58).

The gold particles vary in shape from equant, smooth, subrounded forms to ragged, irregularly shaped to angular grains, the latter typical to the fracture controlled gold within unoxidized or partially oxidized pyrite. Minute inclusions within pyrite are typically the smooth, subrounded type (Photograph 56). The inclusions may occur with sulphide minerals including galena and chalcopyrite.

The mineral assemblage consisted primarily of pyrite with lesser Fe-Ti oxides and secondary iron oxyhydroxides. Pyrite formed idiomorphic to xenomorphic, weakly to strongly fractured crystals ranging in size from less than 20 through 350 microns and average approximately 25 microns. Liberation is very high (greater than 85%) with individual particles having silicate content from nil through 45%. The very fine grained pyrite crystals, typically less than 10-20 microns exhibited poor liberation with sulphide contents of 1% to 5% of particle volumes. Sieve textures were nil to very strong with porosity infilled by chalcopyrite, galena, rutile, gold, zircon and other silicates. Oxidation of pyrite to secondary FeOOH ranges from nil to 100%. Approximately 73.5% of pyrite particles exhibited no oxidation with 17.5% exhibiting less than 50% oxidation. Greater than 50% oxidation was reported

in 9% of the pyrite fragments. The iron oxyhydroxides exhibit progressive cusped to lobate replacement fronts, with compact, massive, colloformic and banded textures. Massive in-situ replacement and banded allochthonous coatings of FeOOH were observed.

Pervasive alteration to iron oxyhydroxides was reported in 7% of the particles of the vanned concentrate. Minor pyrite relicts up to 25 microns are locally disseminated throughout the FeOOH. Coarse particles up to 375 microns in diameter were observed.

Magnetite-ilmenite typically formed subidiomorphic to xenomorphic particles ranging up to 250 microns in diameter. Lamellar twinning and octahedral exsolution textures were very common. Incipient alteration by FeOOH, rutile and sphene characterize grain boundaries and fracture surfaces. Locally, relicts of brown magnetite occurred with coarse aggregates of rutile and sphene after ilmenite.

Hematite typically occurred as fine grained to coarse grained, xenomorphic to idiomorphic blades and laths up to 100 microns in length. Coarse particles of equant to elongate form, up to 230 x 530 microns, were observed. The majority of the hematite laths are fine grained, 6 to 60 microns in length with intergrown silicate gangue. Excellent simple to lamellar twins were present.

Chalcopyrite occurred as coarse liberated grains up to 150 by 275 microns, middling grains with pyrite up to 45 x 180 microns, and with hematite up to 30 microns, inclusions within pyrite up to 50 x 78 microns, and fracture controlled lenticles, up to 8 x 20 microns, along pyrite grain boundaries. The chalcopyrite grains were typically xenomorphic and exhibit minor degrees of brecciation.

Galena was locally associated as middling particles with chalcopyrite although was primarily observed as minute subrounded to angular inclusions within pyrite. The inclusions, which locally occurred with chalcopyrite, ranged in size from less than 1 micron to 16 microns. Bornite occurred as coarse, liberated particles, up to 85 by 130 microns, containing minute blebs to ribbon lamellae, of less than 10 microns in length, of chalcopyrite. Covellite and chalcocite formed rare alteration rinds around chalcopyrite. The alteration was less than 5-10 microns in thickness and was overcoated by oxyhydroxides.

4.0

CONCLUSIONS

Sample #87-201 - Durham Lake George

1. The mineral assemblage was comprised primarily of pyrite with lesser arsenopyrite and minor to trace amounts of pyrrhotite, marcasite, sphalerite, chalcopyrite, and Fe-Ti oxides.
2. Antimony minerals included stibnite, native antimony, tetrahedrite, and berthierite.
3. Native gold mineralization was not observed. It is suggested that the gold may occur in a submicroscopic association with fine grained arsenopyrite.
4. Trace amounts of sternbergite were tentatively identified by optical properties. This silver-bearing mineral may also contain gold in solid solution.

Sample #87-202 - Lacana Alcida

1. The assemblage was comprised primarily of arsenopyrite with lesser and equal amounts of pyrite and pyrrhotite.
2. The accessory minerals consisted of rutile, sphene, chalcopyrite, marcasite and Fe-Ti oxyhydroxides.
3. Native gold was observed in eight occurrences with a total of 32 grains. The gold was spatially associated with microfractures and grain boundary-intercrystal surfaces within arsenopyrite.

Sample #87-203 - Durham Lake George

1. The mineral assemblage was comprised primarily of arsenopyrite with lesser pyrite.
2. Antimony minerals included stibnite, berthierite, alledmontite, native antimony and tetrahedrite.
3. The accessory assemblage also included pyrrhotite, rutile, sphene, chalcopyrite, and molybdenite.
4. Only two native gold grains were observed in two occurrences. The gold was situated within microfractures in arsenopyrite.
5. The high gold assays suggest that submicroscopic gold may form associations with arsenopyrite or another sulfide mineral.
6. The silver-bearing mineral, sternbergite, was common and may also contain gold values in solid solution.

Sample #87-251 - Gordex Cape Spencer

1. The mineral assemblage was dominated by pyrite with lesser Fe-Ti oxides.
2. The sulfides, comprising approximately 4% of the mode, consisted of galena, chalcopyrite, stibnite, arsenopyrite, pyrrhotite, and tetrahedrite-tennantite.
3. Four grains of native gold were observed in three occurrences. The gold was associated with microfractures in pyrite.

Sample #87-252 - Gordex Cape Spencer

1. The mineral assemblage was dominated by pyrite, hematite and iron oxyhydroxides. Incipient to pervasive oxidation characterizes approximately 50% of the pyritic mineralization .
2. The accessory assemblage consisted of minor amounts of magnetite-ilmenite with trace amounts of pyrrhotite, chalcopyrite, stibnite, arsenopyrite, native antimony, galena, and tetrahedrite-tennantite.
3. Eighty-six grains of native gold were observed within sixteen occurrences. The minute particles of gold were spatially associated with pyrite and its secondary oxidation products. Gold occurred as encapsulations within pyrite and oxyhydroxides, on microfractures in pyrite, and as middling exposed grains adjacent to both pyrite and oxyhydroxides.

Sample #87-253 - Gordex Cape Spencer

1. The mineral assemblage was dominated by pyrite with lesser oxyhydroxide alteration products. Approximately 28% of the particles exhibited incipient to pervasive oxidation.
2. The accessory assemblage was comprised of hematite, magnetite, rutile, sphene, chalcopyrite, galena, bornite and chalcocite-covellite.
3. Thirty-six grains of native gold were observed in thirty-one occurrences. The gold particles were spatially associated with pyrite and iron oxyhydroxides. Particles up to 80 x 88 microns were observed though the gold was primarily less than 25 microns. Gold particles occurred within massive pyrite crystals, microfractures within pyrite and also within porous to compact iron oxyhydroxides.

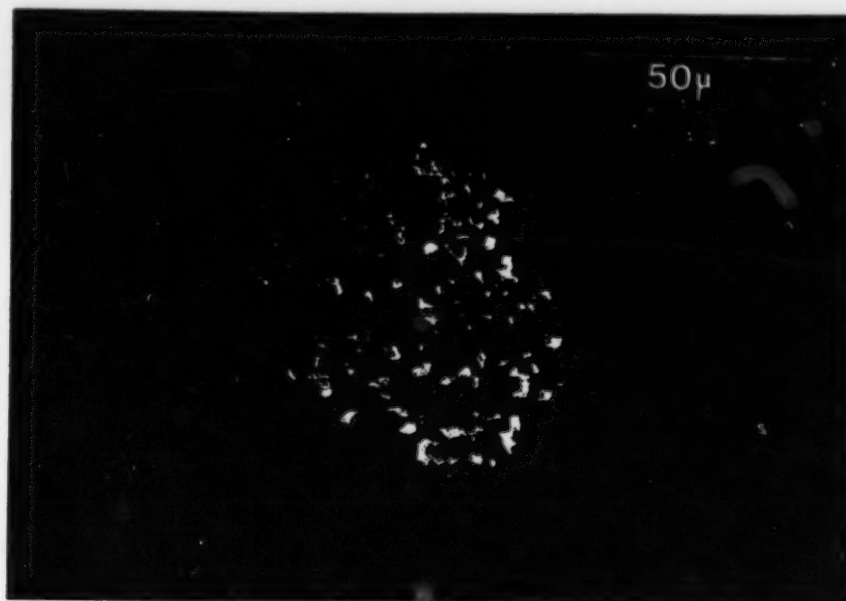
APPENDIX I

Photomicrographs and SEM-EDXA Spectra

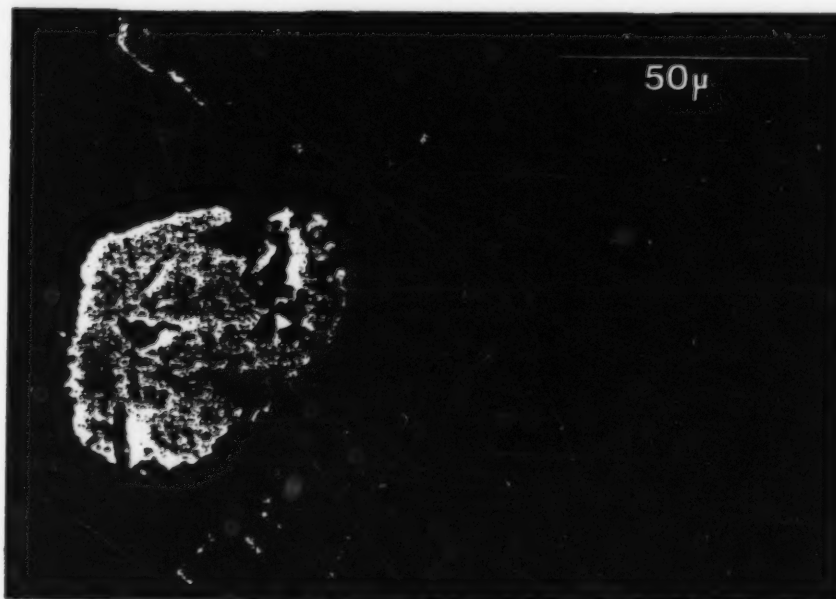
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Sample #87-201

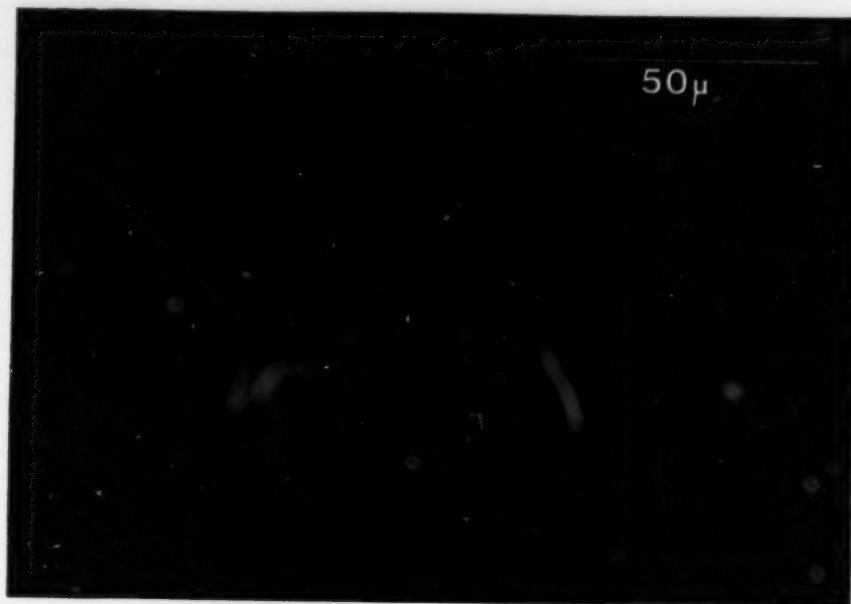
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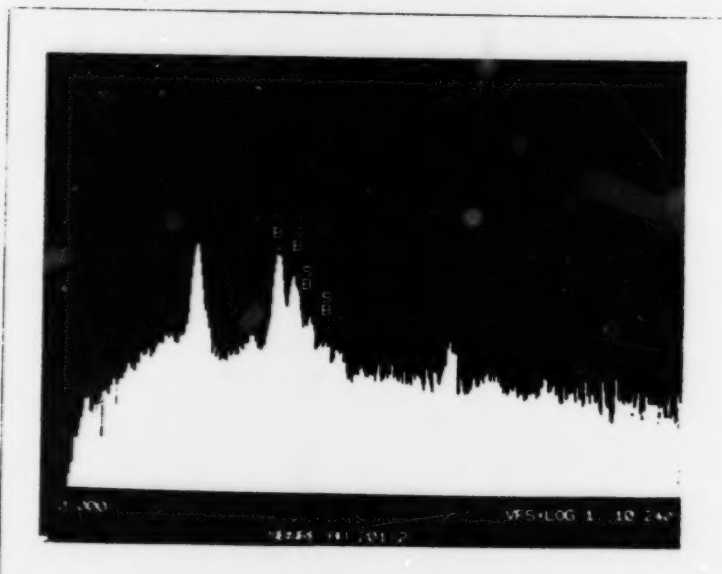
Photograph 1. 500 X Reflected Light
Idiomorphic to xenomorphic crystals and grain aggregates
of native antimony (white, high reflectance) cemented
by xenomorphic pyrrhotite. Native antimony exhibits
massive to dendritic skeletal textures, locally
containing infilling by pyrrhotite.



Photograph 2. 500 X Reflected Light
Coarse crystal aggregate of native antimony enclosing
fracture controlled xenomorphic particles of pyrrhotite
(pale brown), stibnite (pale grey) and tetrahedrite
(dark grey). Equigranular aggregates of pyrite and
arsenopyrite (at top right) exhibit poor liberation
from silicate gangue.



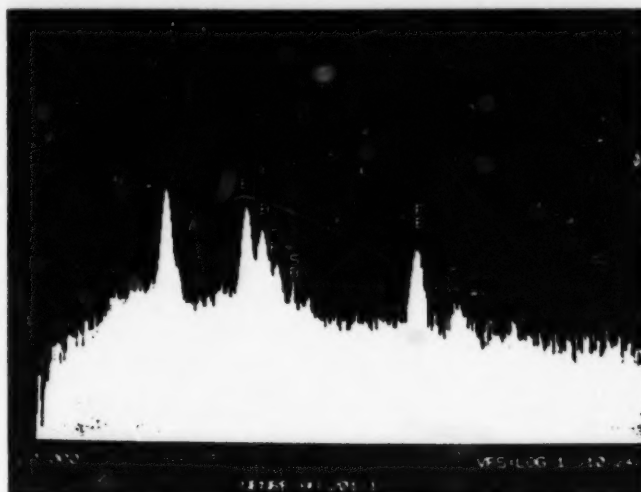
Photograph 3. 500 X Reflected Light
Brecciated xenomorphic to subidiomorphic pyrite with
fracture controlled cementation by dark grey tetrahedrite.



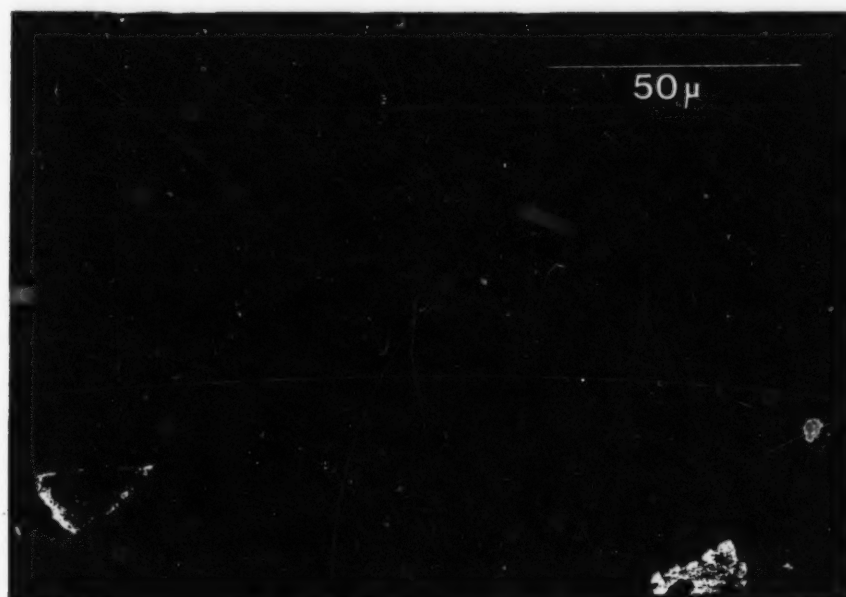
SEM-EDXA spectra of coarse stibnite grain (Sb_2S_3)
(photomicrograph not shown).

1003A

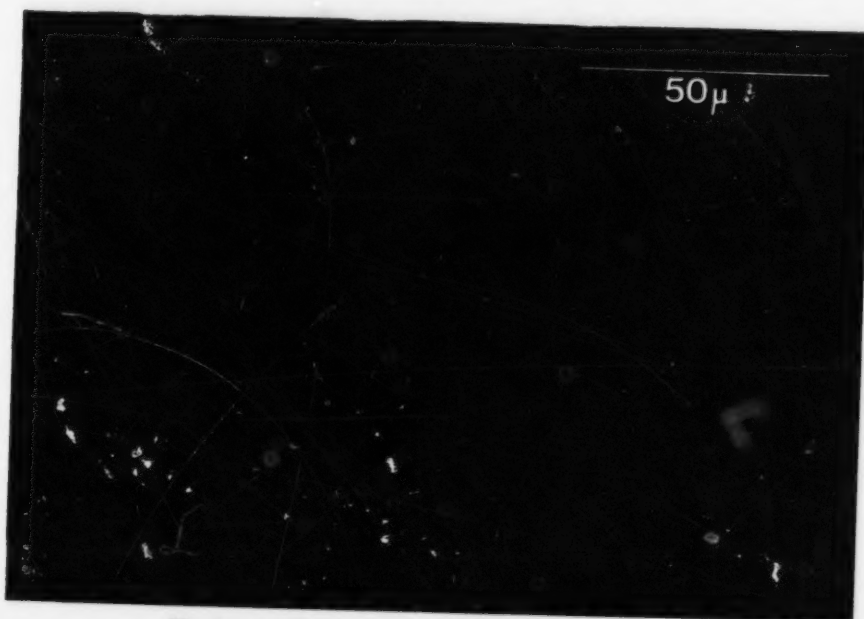
WD



Photograph 5.
SEM-EDXA spectra of coarse berthierite crystal aggregate
(FeSb_2S_4) (photomicrograph not shown).



Photograph 6. 500 X Reflected Light
Liberated particles of subidiomorphic to xenomorphic
pyrite (pale yellow), arsenopyrite (white) and pyrrhotite
(brown). The host hexagonal pyrrhotite (darker brown)
exhibits numerous twisted lamellae of monoclinic pyrrhotite.
1003A



Photograph 7. 500 X Reflected Light
Aggregate of atoll structures comprising cores of fine
grained pyrite and pyrrhotite overgrown by idiomorphic
to subidiomorphic crystals and crystal aggregates of pyrite.
Silicate gangue formed interstitial to the sulphide aggregates

1003A

Sample #87-202

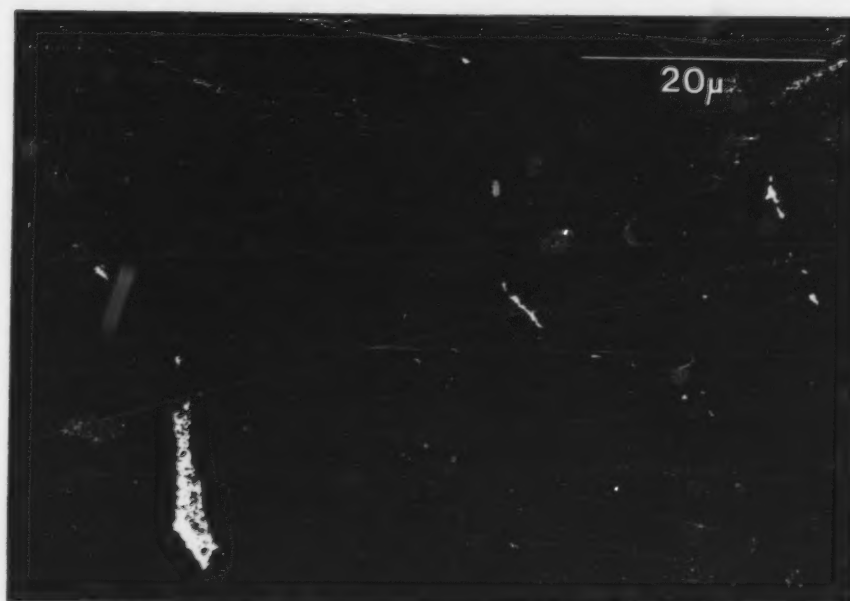
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Photograph 8. 500 X Reflected Light
Crystal aggregate of idiomorphic to subidiomorphic pyrite
containing fracture and grain boundary controlled gold
mineralization. Native gold and pyrrhotite form cement
interstitial to the pyrite.



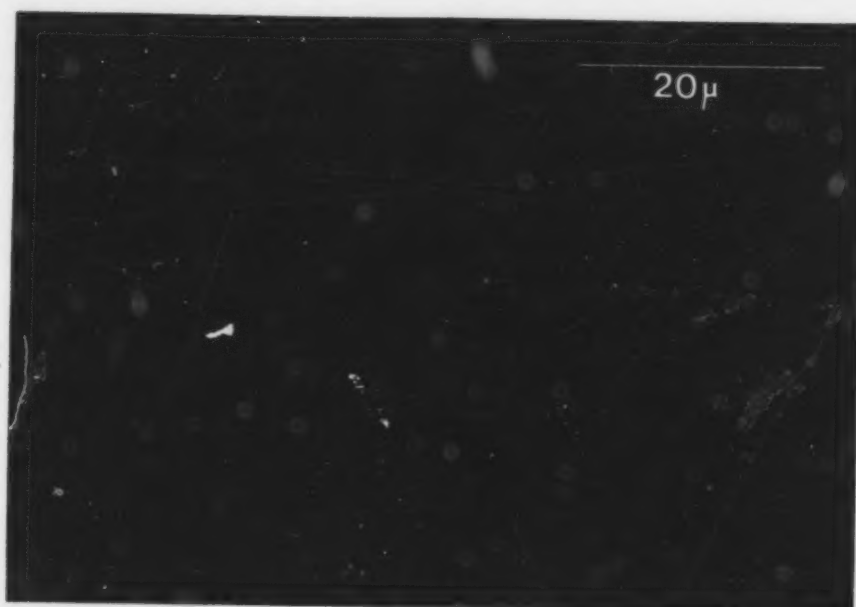
Photograph 9. 1250 X Reflected Light (oil immersion)
Numerous irregular lenticles of native gold and pyrrhotite
heal microfractures and intercrystal porosity within
pyrite aggregate.



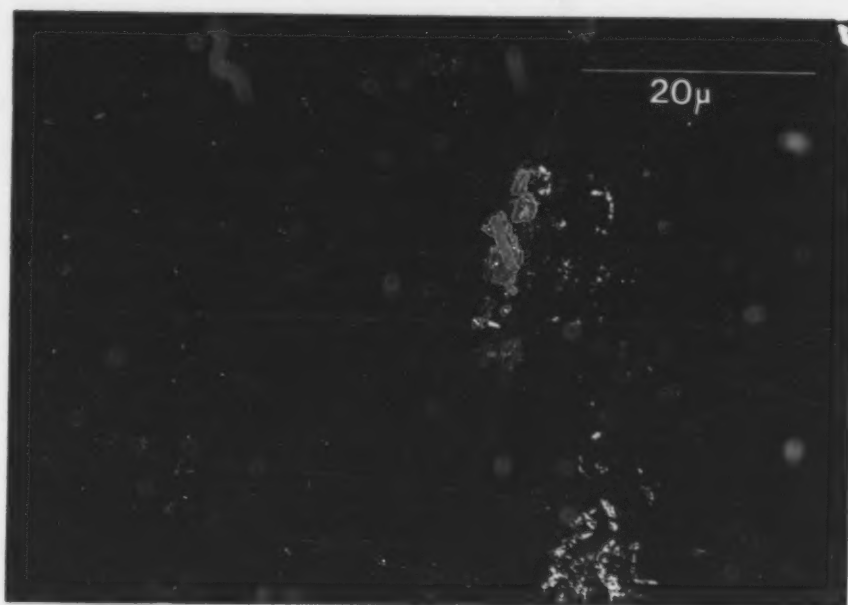
Photograph 10. 1250 X Reflected Light (oil immersion)
Angular grain boundary controlled native gold particle
in middling exposed association with idiomorphic pyrite
and interstitial pyrrhotite cement.



Photograph 11. 1250 X Reflected Light (oil immersion)
Fine grained angular particles of native gold, in middling
association, exposed at periphery of idiomorphic pyrite
and coarse xenomorphic pyrrhotite cement. Native gold
occurrences typically occurred at contact between
pyrite and pyrrhotite.

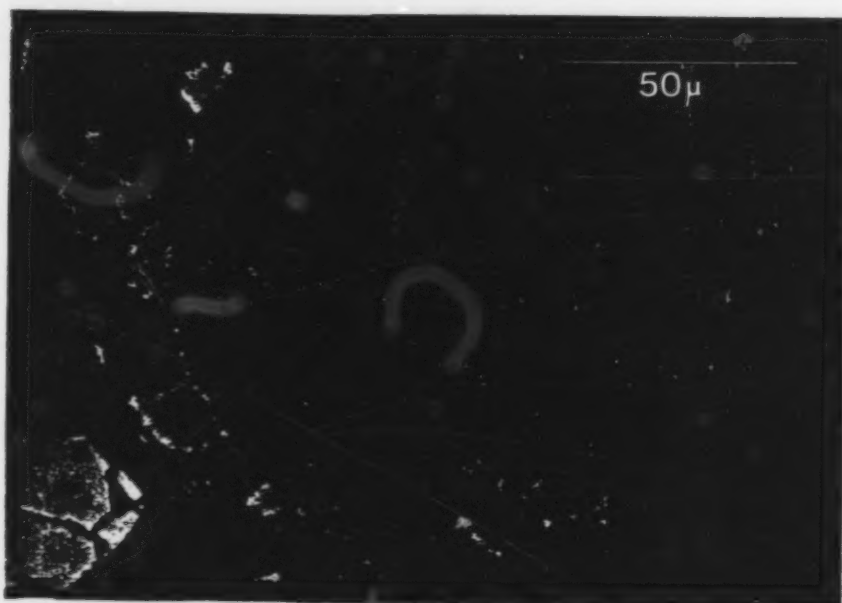


Photograph 12. 1250 X Reflected Light (oil immersion)
Angular fracture controlled native gold mineralization
within strongly fractured pyrite. The pyrite also exhibits
minor replacement by pyrrhotite adjacent to fractures.



Photograph 13. 1250 X Reflected Light (oil immersion)
Minute particles of native gold enclosed along healed
fracture within fine grained aggregate of pyrite.
The pyrite aggregates and coarse subidiomorphic crystals
form islands within pyrrhotite cement.

1003A

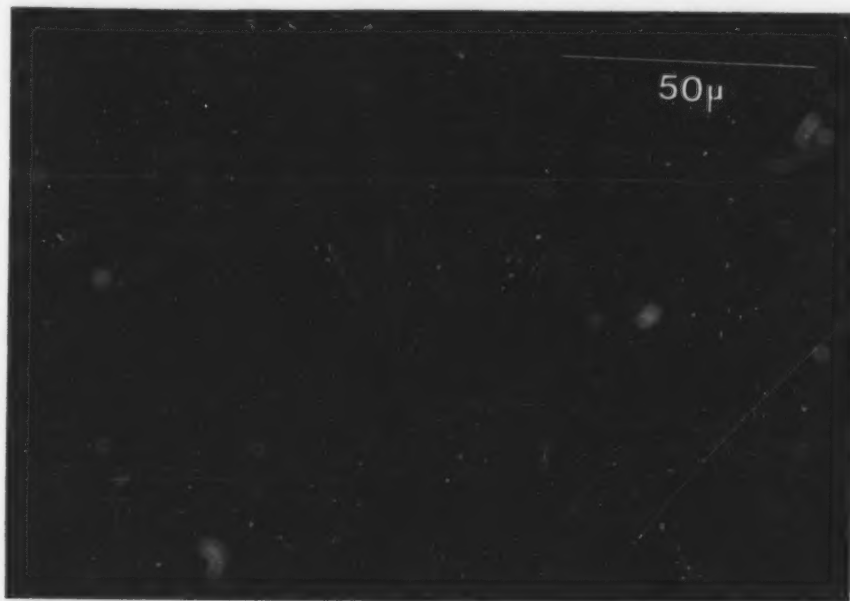


Photograph 14. 500 X Reflected Light
Coarse aggregate of idiomorphic to subidiomorphic
arsenopyrite, locally exhibiting dendritic texture,
cemented by hexagonal and monoclinic pyrrhotite with
minor chalcopyrite.

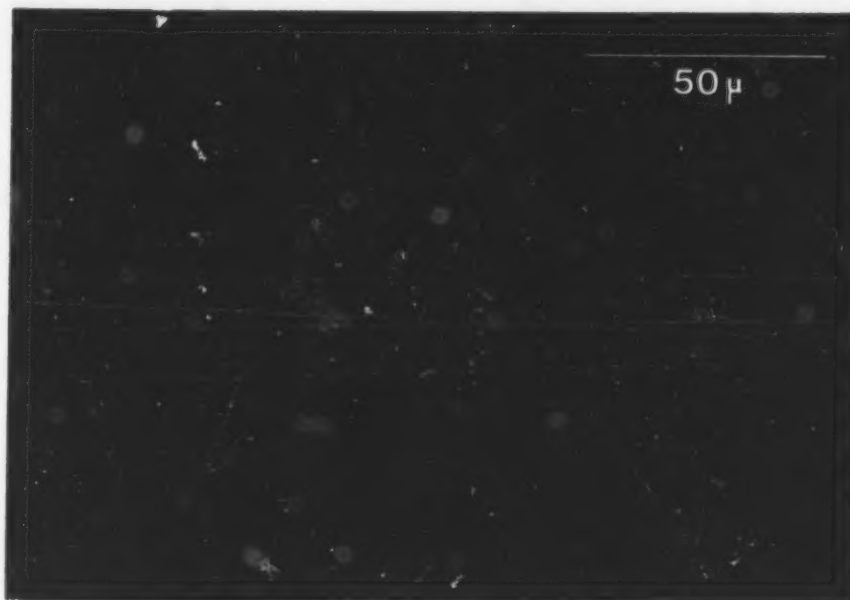


Photograph 15. 200 X Reflected Light
Subidiomorphic to xenomorphic pyrite exhibits
overgrowth replacement and cementation by pyrrhotite.

1003A



Photograph 16. 500 X Reflected Light
Myrmekitic intergrowth between chalcopyrite and pyrrhotite.



Photograph 17. 500 X Reflected Light
Coarse equigranular aggregate of hematite, probably
replacing pyrrhotite (several relict grains present),
and containing numerous disseminated particles of
subidiomorphic to idiomorphic arsenopyrite.

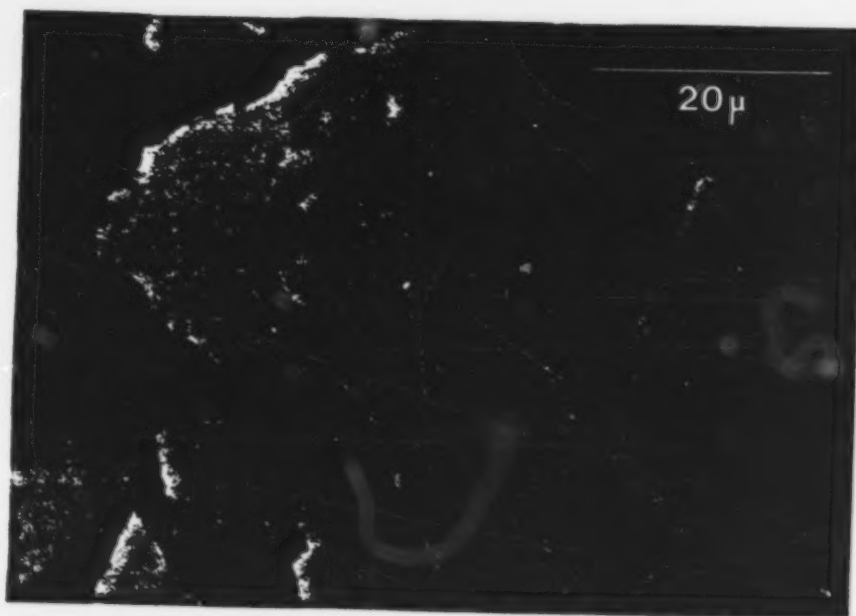
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Sample #87-203

1003A



Photograph 18. 1250 X Reflected Light (oil immersion)
Minute particle of native gold within open microfracture
of subidiomorphic arsenopyrite.

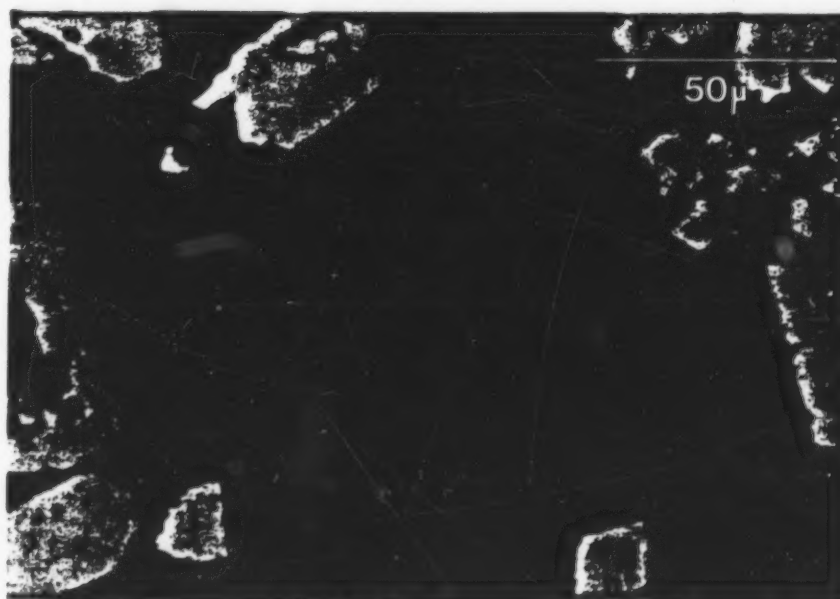


Photograph 19. 1250 X Reflected Light (oil immersion)
Minute particle of native gold within microfracture
of idiomorphic to subidiomorphic arsenopyrite.

1003A

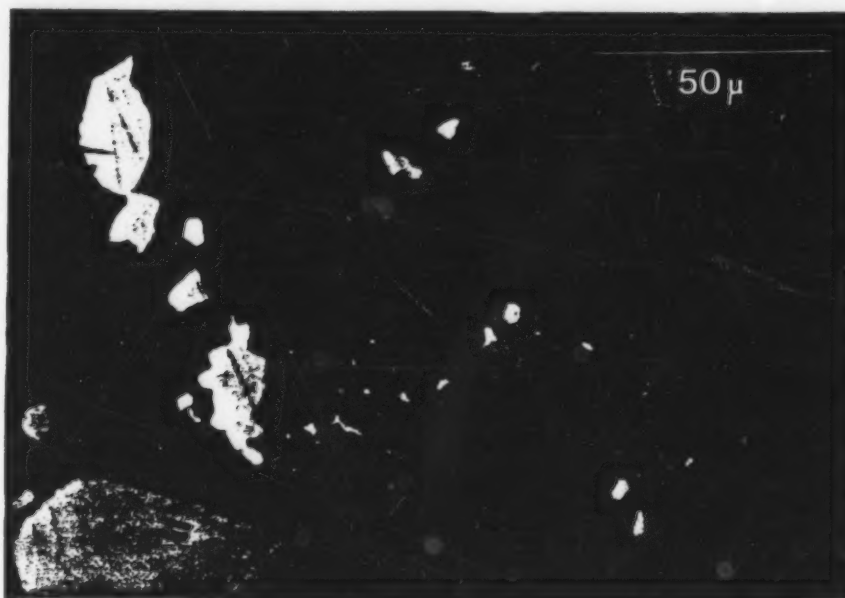


Photograph 20. 500 X Reflected Light
Coarse liberated xenomorphic particle of stibnite
exhibiting abundant lamellar twins.

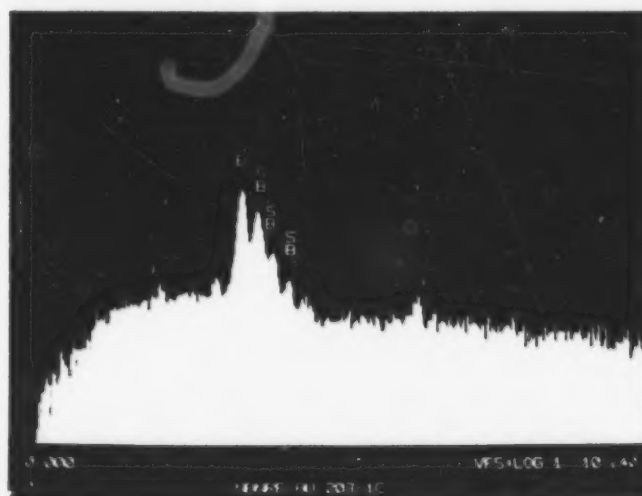


Photograph 21. 500 X Reflected Light
Aggregate of prismatic to equant crystals of berthierite
and stibnite with abundant intercrystal porosity.

1003A

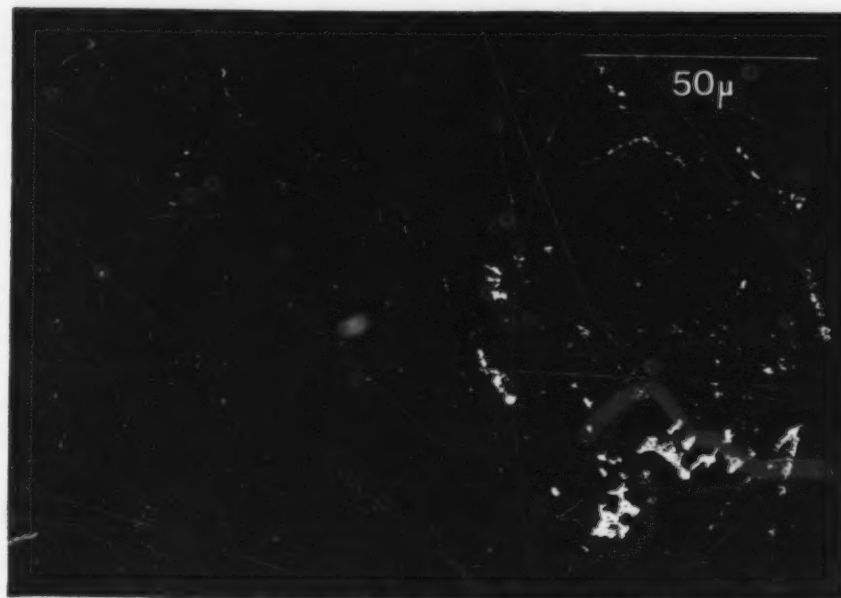


Photograph 22. 500 X Reflected Light
Coarse xenomorphic crystal aggregate of pyrrhotite
enclosing irregular xenomorphic to subidiomorphic
crystals and crystal aggregates of native antimony.

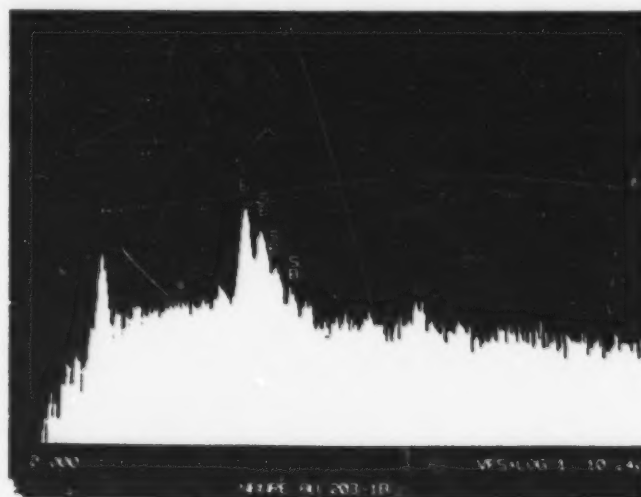


Photograph 23.
SEM-EDXA spectra of native antimony.

1003A

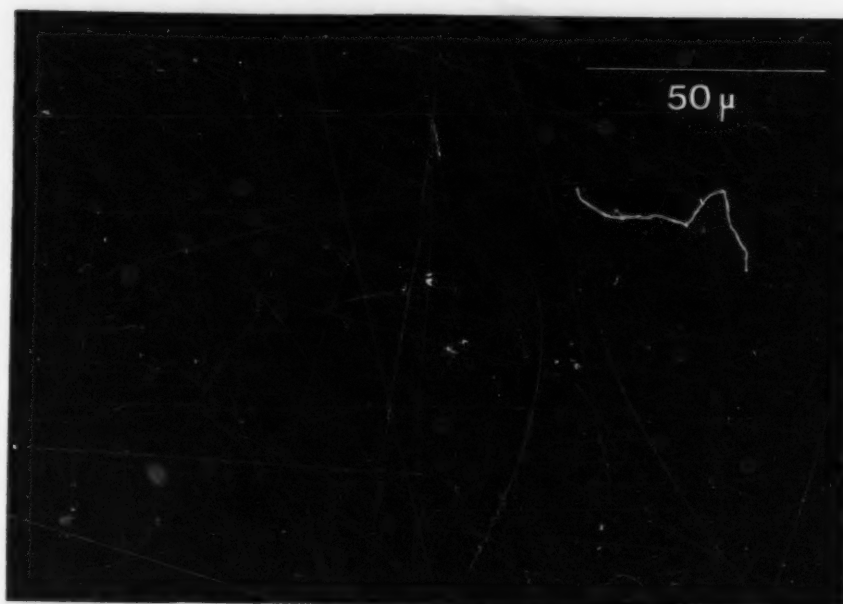


Photograph 24. 500 X Reflected Light
Polymineralic aggregate of porous, highly fractured, subidiomorphic to xenomorphic stibnite (dark grey) overgrown and replaced by allemontite (pale grey-brown) and native antimony. The latter exhibits fracture controlled mineralization and also deposition within intercrystal porosity between allemontite and stibnite.



Photograph 25.
SEM-EDXA spectra of allemontite (stibarsen).

1003A

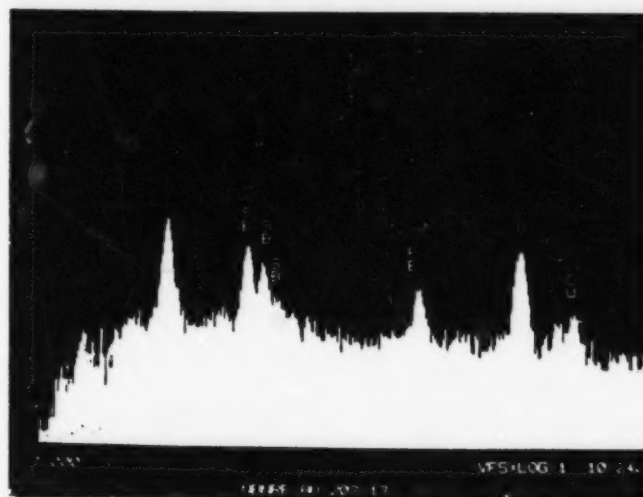


Photograph 26. 500 X Reflected Light
Xenomorphic particle of chalcopyrite enclosing
subidiomorphic pyrite and xenomorphic grains of native
antimony. The antimony exhibits a fracture controlled
or grain boundary controlled depositional texture.

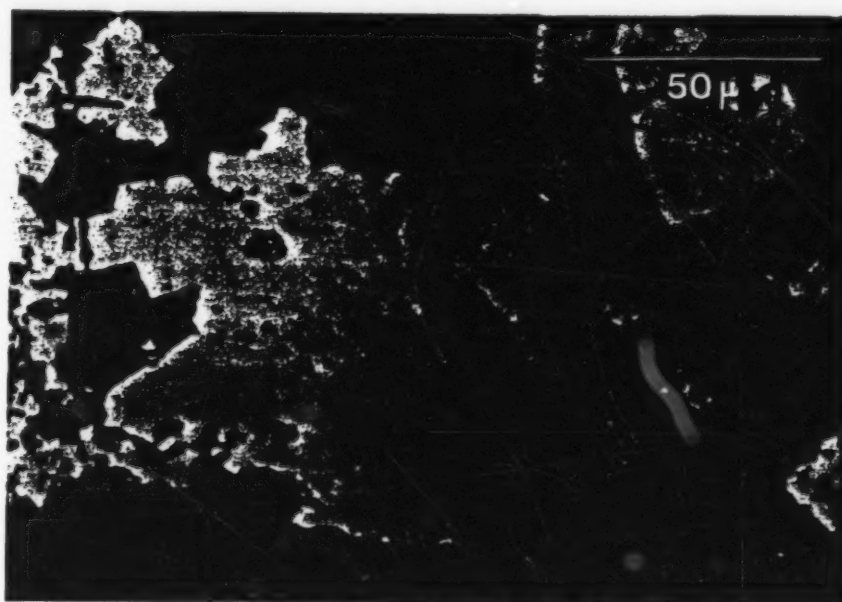


Photograph 27. 500 X Reflected Light
Idiomorphic to subidiomorphic crystals and aggregates of
arsenopyrite (white) and very fine grained pyrite (yellow)
are cemented by coarse tetrahedrite (grey-brown) and minor
chalcopyrite (dark yellow). The chalcopyrite may follow grain
boundaries of the sulphosalt cement.

1003A

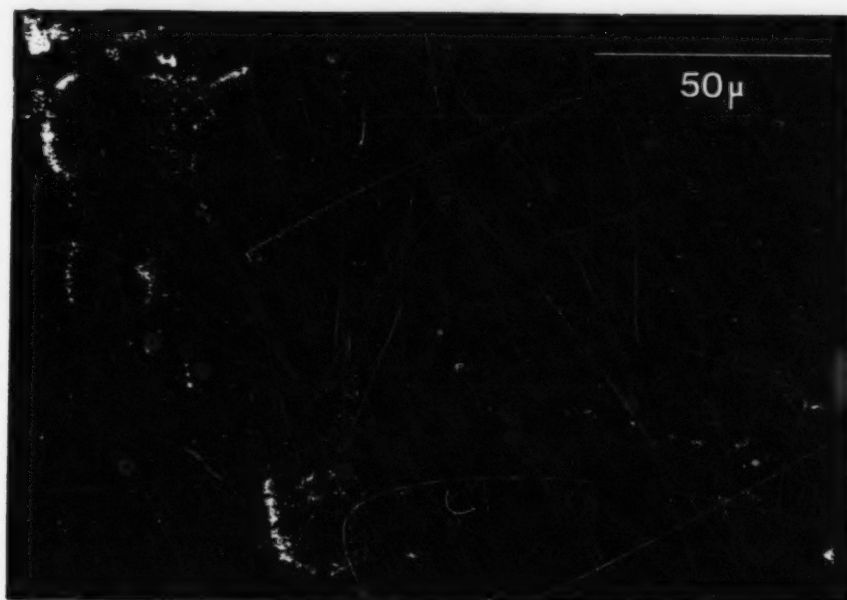


Photograph 28.
SEM-EDXA spectra of tetrahedrite $\text{Cu}_{12}\text{Sb}_4\text{S}_{13}$.

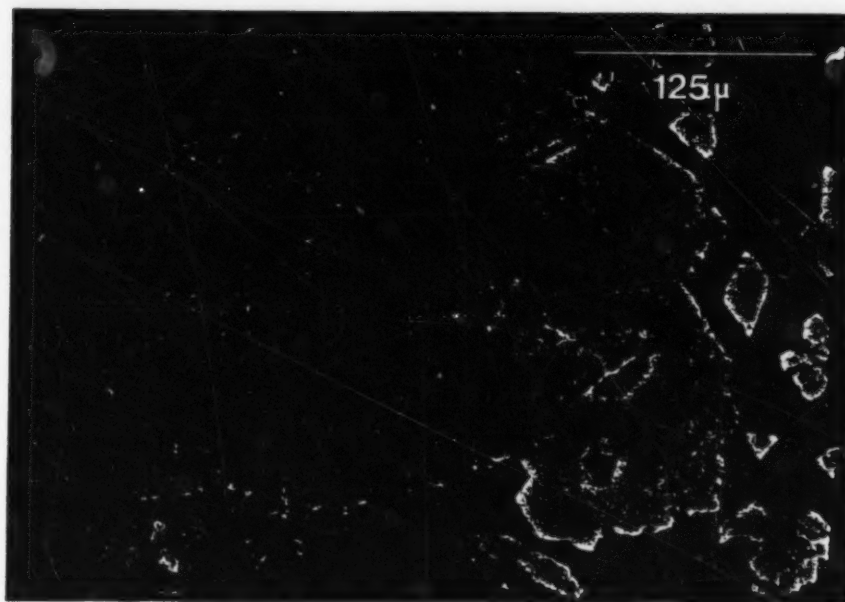


Photograph 29. 500 X Reflected Light
Coarse aggregate of idiomorphic arsenopyrite and minor
pyrite cemented by tetrahedrite. Minute particles of
native antimony occur at the interface of the
arsenopyrite and tetrahedrite.

1003A

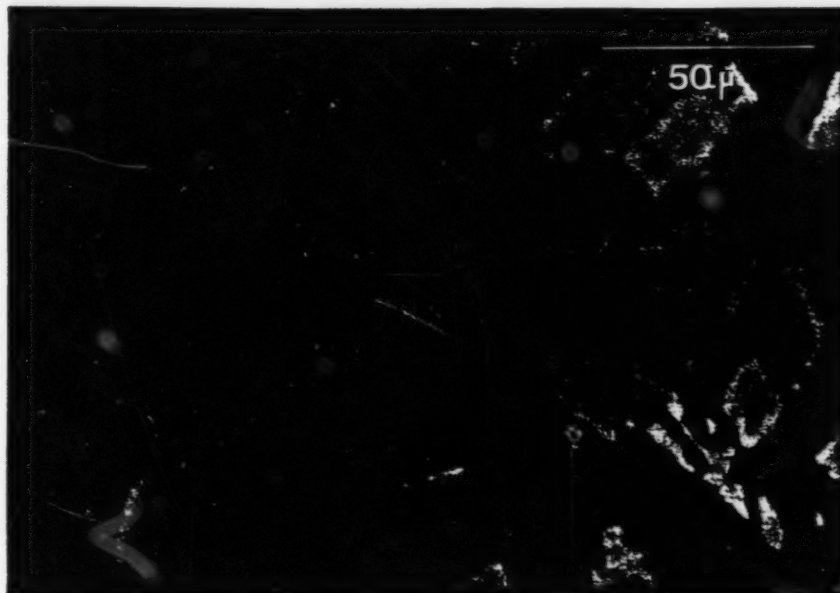


Photograph 30. 500 X Reflected Light
Aggregate of subidiomorphic to idiomorphic arsenopyrite exhibits interstitial pyrite (yellow), stibnite (light grey), berthierite (grey-brown lamellar) and tetrahedrite (dark grey).

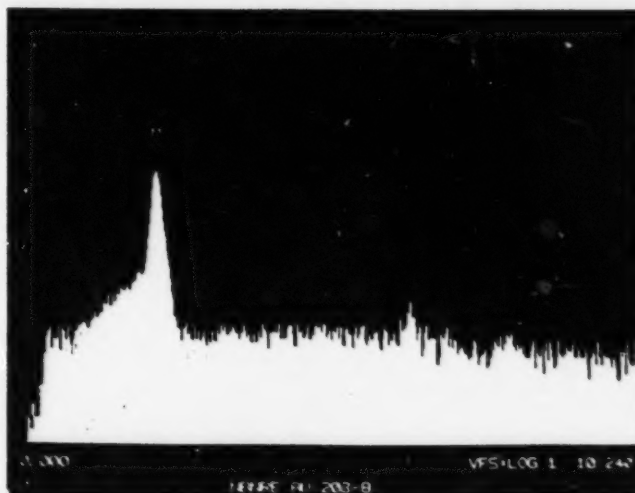


Photograph 31. 200 X Reflected Light
Similar grain aggregate of idiomorphic arsenopyrite with extensive cementation by pyrite and lesser tetrahedrite and chalcopyrite.

1003A

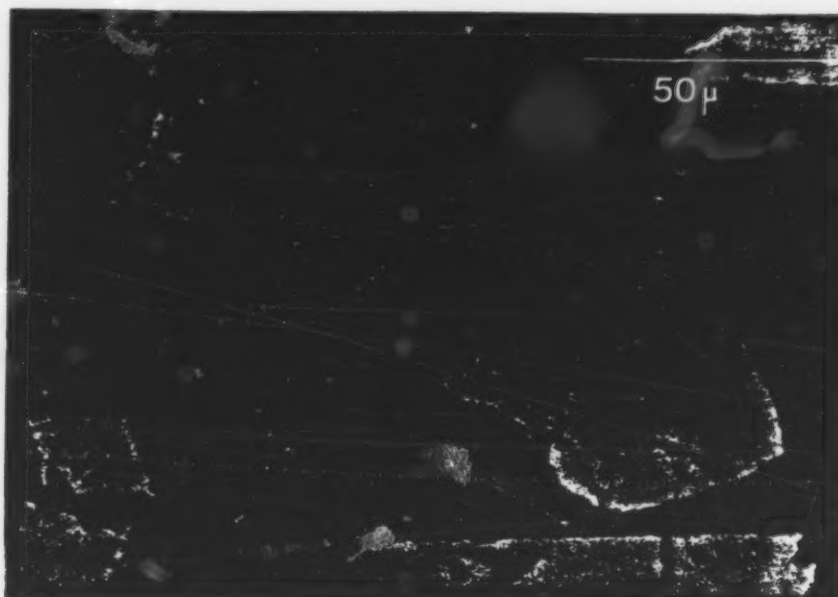


Photograph 32. 500 X Reflected Light
Ragged particle of molybdenite exhibiting twisted
flakes locally intergrown with grey stibnite.

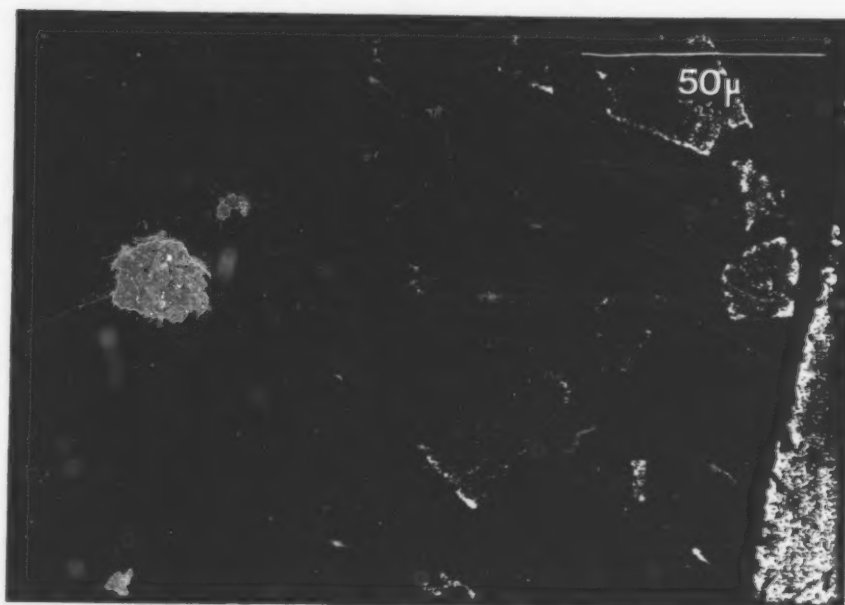


Photograph 33.
SEM-EDXA spectra of molybdenite, MoS_2 .

1003A

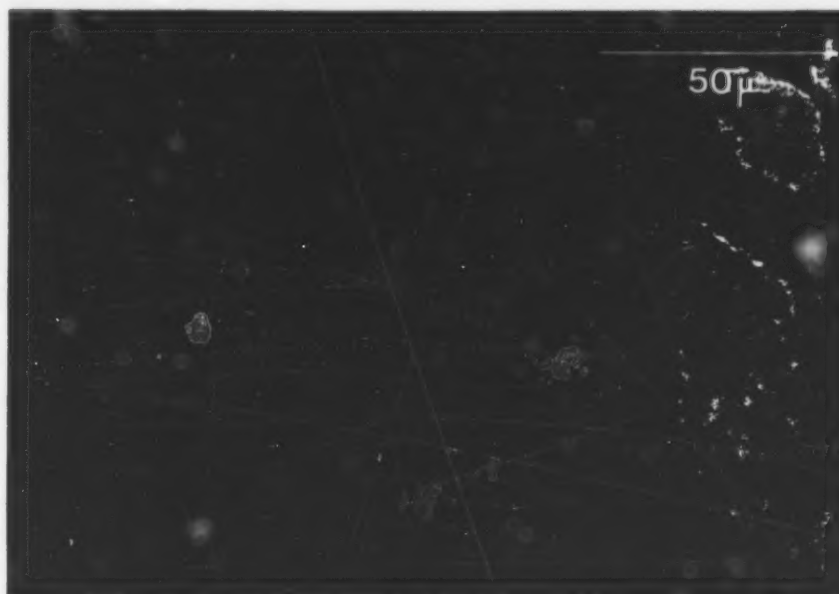


Photograph 34. 500 X Reflected Light
Prismatic crystal of arsenopyrite exhibits peripheral
grain boundary controlled cementation overgrowth by
flaky, pitted sternbergite.



Photograph 35. 500 X Reflected Light
Idiomorphic arsenopyrite exhibits partial rind of
bent platy flakes of sternbergite.

1003A

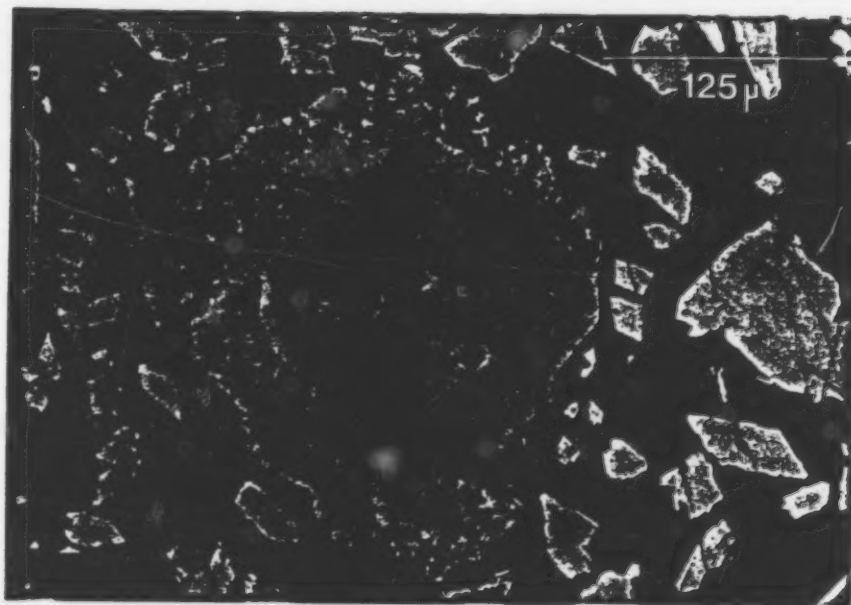


Photograph 36. 500 X Reflected Light
Idiomorphic arsenopyrite in middling association with
pyrrhotite (yellow-brown) and strongly pitted
(darker brown) sternbergite.



Photograph 37. 500 X Reflected Light
Coarse aggregate of subidiomorphic arsenopyrite exhibits
extensive cleavage-controlled replacement by rutile
and lesser sphene.

1003A

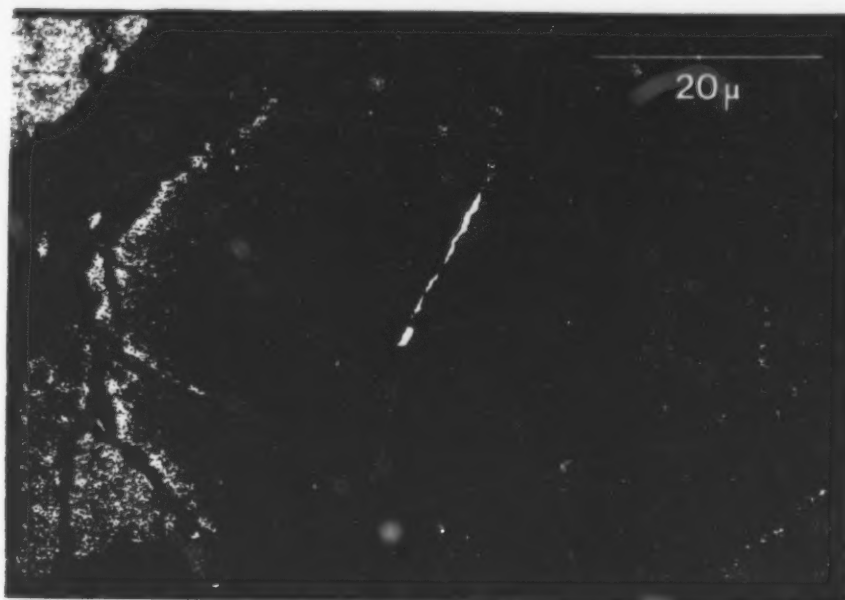


Photograph 38. 200 X Reflected Light
Idiomorphic pyrite exhibits overgrowth of skeletal
ragged pyrite intergrown with silicate gangue.

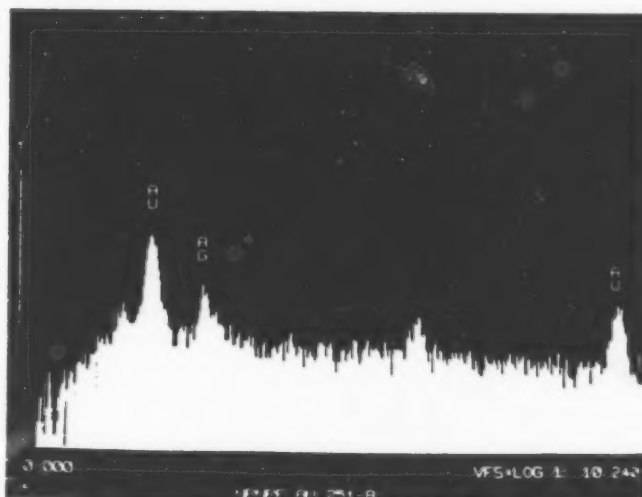
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Sample #87-251

1003A



Photograph 39. 1250 X Reflected Light (oil immersion)
Fine grained lenticle of native gold along grain
boundary of subidiomorphic pyrite.



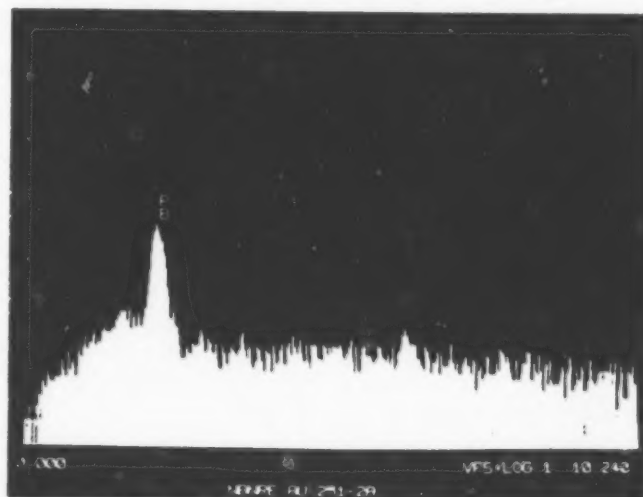
Photograph 40.
SEM-EDXA spectra of native gold.

1003A

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Photograph 41. 500 X Reflected Light
Aggregate particle of sub-equant stibnite exhibits
strong pleochroism and equigranular texture.

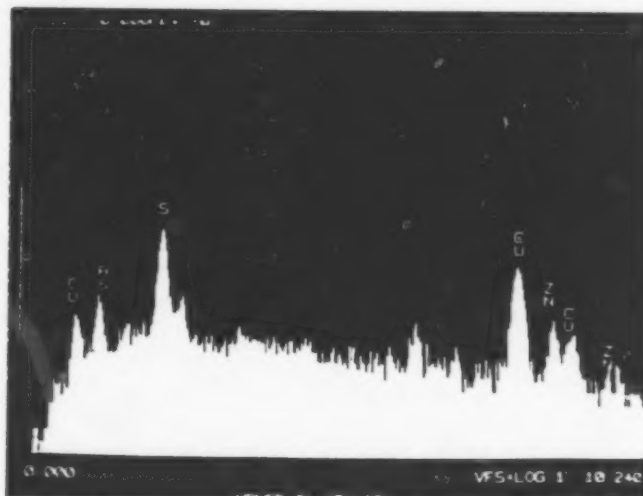


Photograph 42.
SEM-EDXA spectra of galena, PbS.

1003A



Photograph 43. 500 X Reflected Light
Idiomorphic galena (pale grey, abundant triangular pits)
in consertal middling association with tetrahedrite
(dark grey-brown) and minor cleavage controlled lenticles
of chalcopyrite.



Photograph 44.
SEM-EDXA spectra of tennantite, $(\text{Cu}, \text{Zn}, \text{Fe})_{12}\text{As}_4\text{S}_{13}$.

1003A

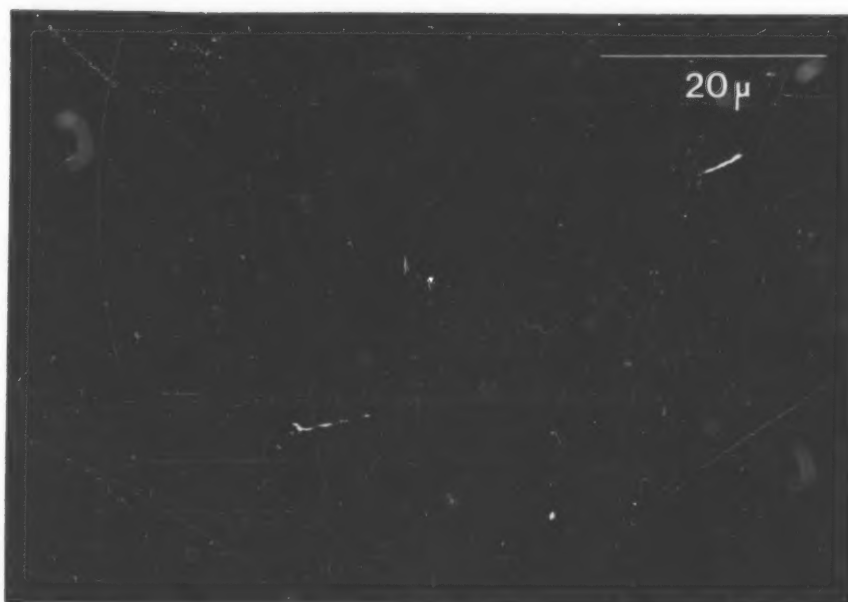
Sample #87-252

1003A

WDI

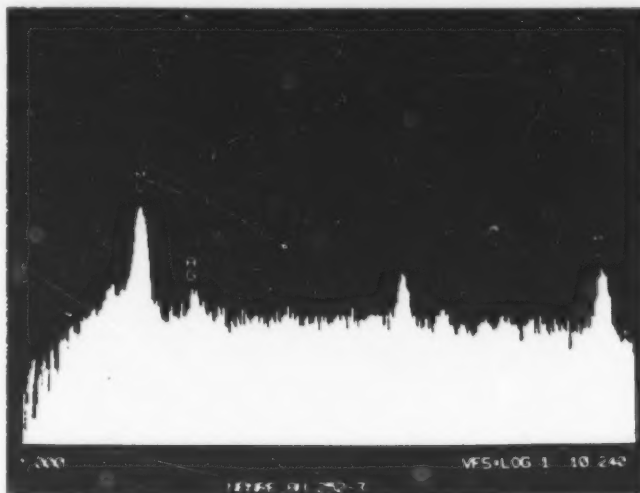


Photograph 45. 1250 X Reflected Light (oil immersion)
Minute particles of native gold enclosed within pyrite.

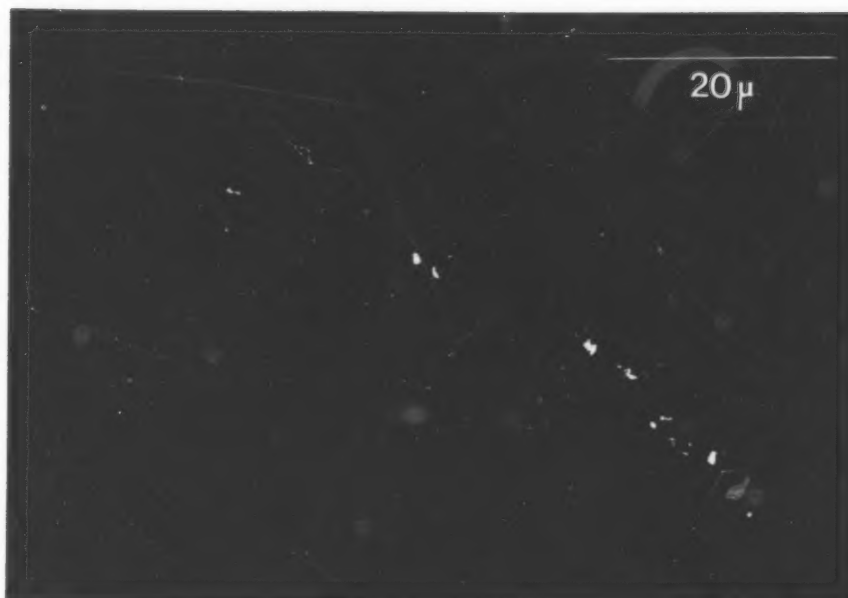


Photograph 46. 1250 X Reflected Light (oil immersion)
Fine lenticles of native gold within secondary
iron hydroxides adjacent to relict pyrite.

1003A



Photograph 47.
SEM-EDXA spectra of native gold.



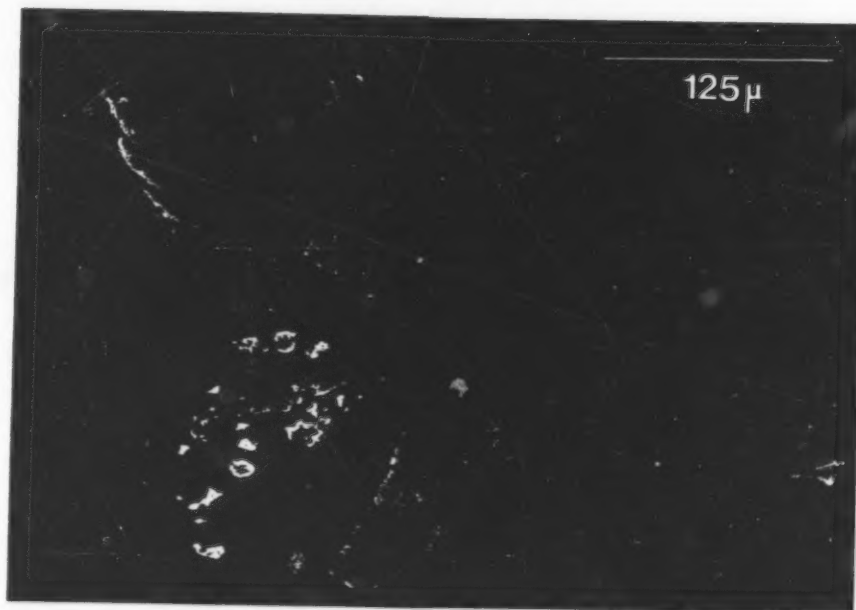
Photograph 48. 1250 X Reflected Light (oil immersion)
Numerous minute flecks of native gold within porous
secondary iron hydroxides after pyrite.

1003A

WDI



Photograph 49. 200 X Reflected Light
Coarse pyrite exhibits progressive oxidation by
periphery-controlled lobes of secondary iron hydroxides.



Photograph 50. 200 X Reflected Light
Minute subidiomorphic to idiomorphic crystals of native
antimony enclosed by silicate minerals and pyrrhotite.
Coarse particles of relict pyrite exhibit peripheral
oxidation to iron oxyhydroxides.

1003A



Photograph 51. 200 X Reflected Light
Coarse subidiomorphic magnetite exhibiting characteristic
development of martite by lamellar replacement with hematite.

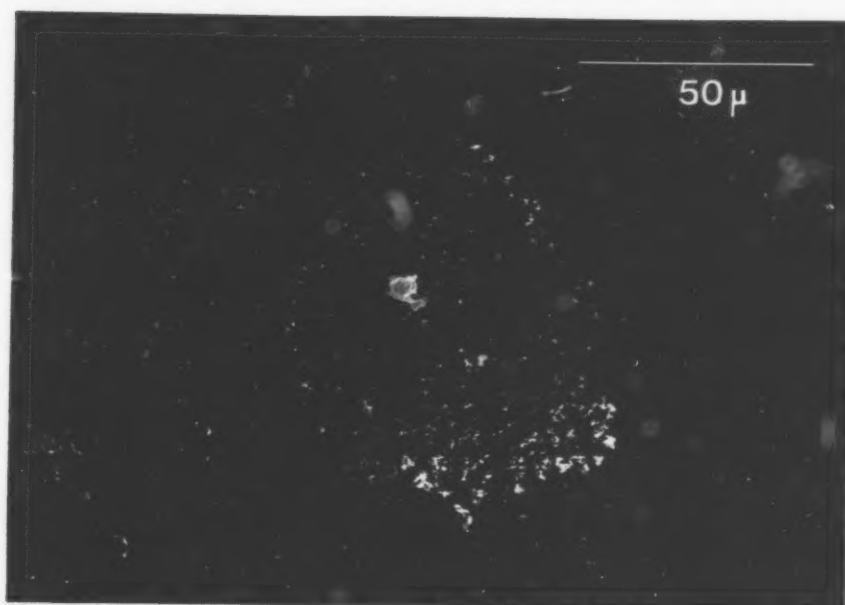


Photograph 52. 200 X Reflected Light
Radiating array of idiomorphic hematite.

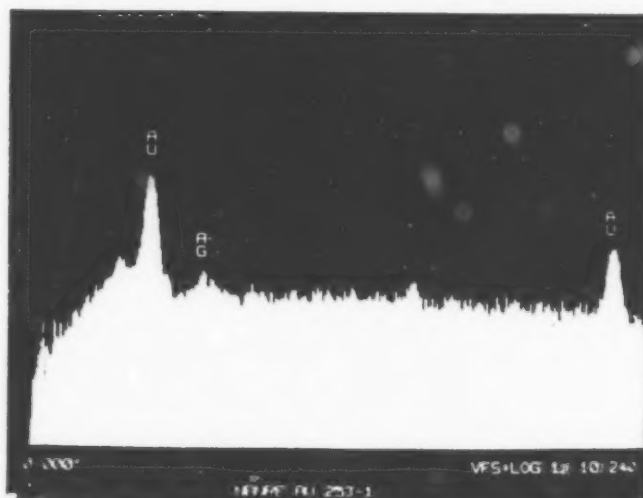
1003A

Sample #87-253

1003A

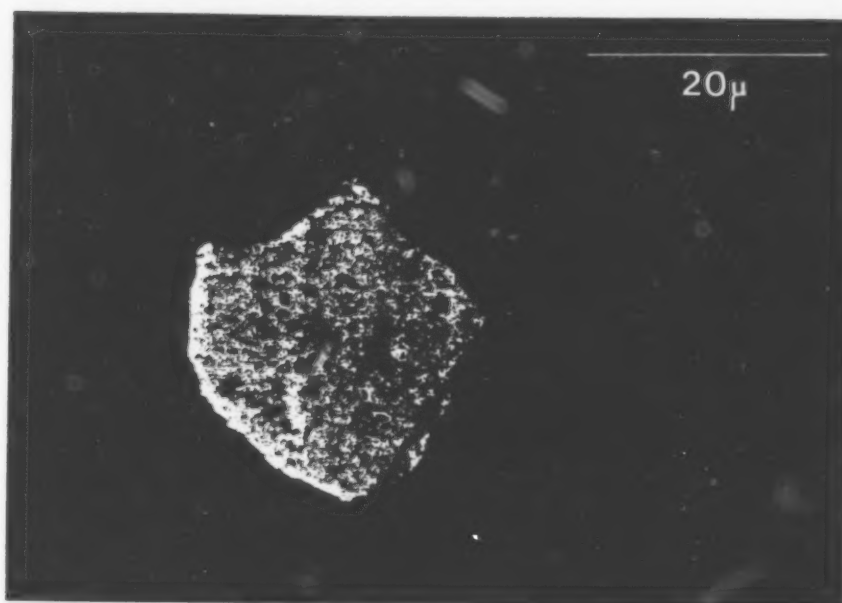


Photograph 53. 500 X Reflected Light
Coarse subrounded particles of native gold exhibit
fracture controlled mineralization within brecciated pyrite.

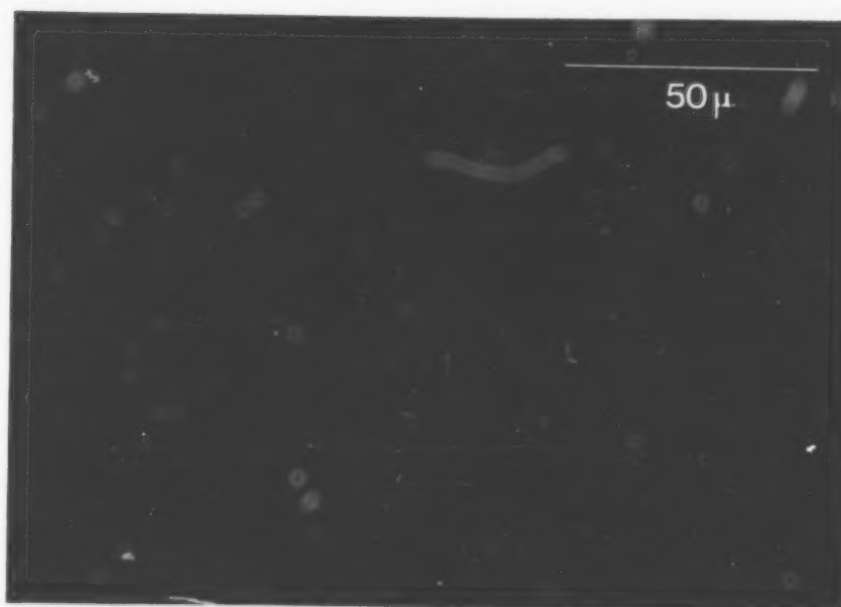


Photograph 54.
SEM-EDXA spectra of native gold.

1003A



Photograph 55. 1250 X Reflected Light (oil immersion)
Middling exposed association between coarse intercrystal
gold mineralization and host pyrite.

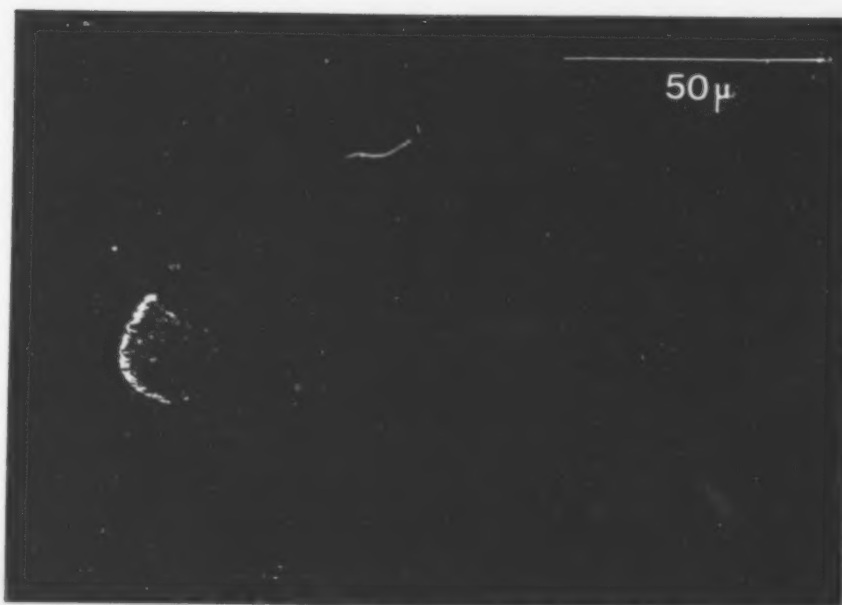


Photograph 56. 500 X Reflected Light
Subrounded particles of native gold encapsulated
within massive, subidiomorphic pyrite.

1003A



Photograph 57. 1250 X Reflected Light (oil immersion)
Irregular, fracture controlled native gold mineralization.
Pyrite exhibits preferential oxidative replacement
adjacent to coarse microfractures.



Photograph 58. 500 X Reflected Light
Subrounded particle of native gold in middling
exposed association with compact iron oxyhydroxide
replacement of pyrite.

1003A